JULY 1958

Power Engineering

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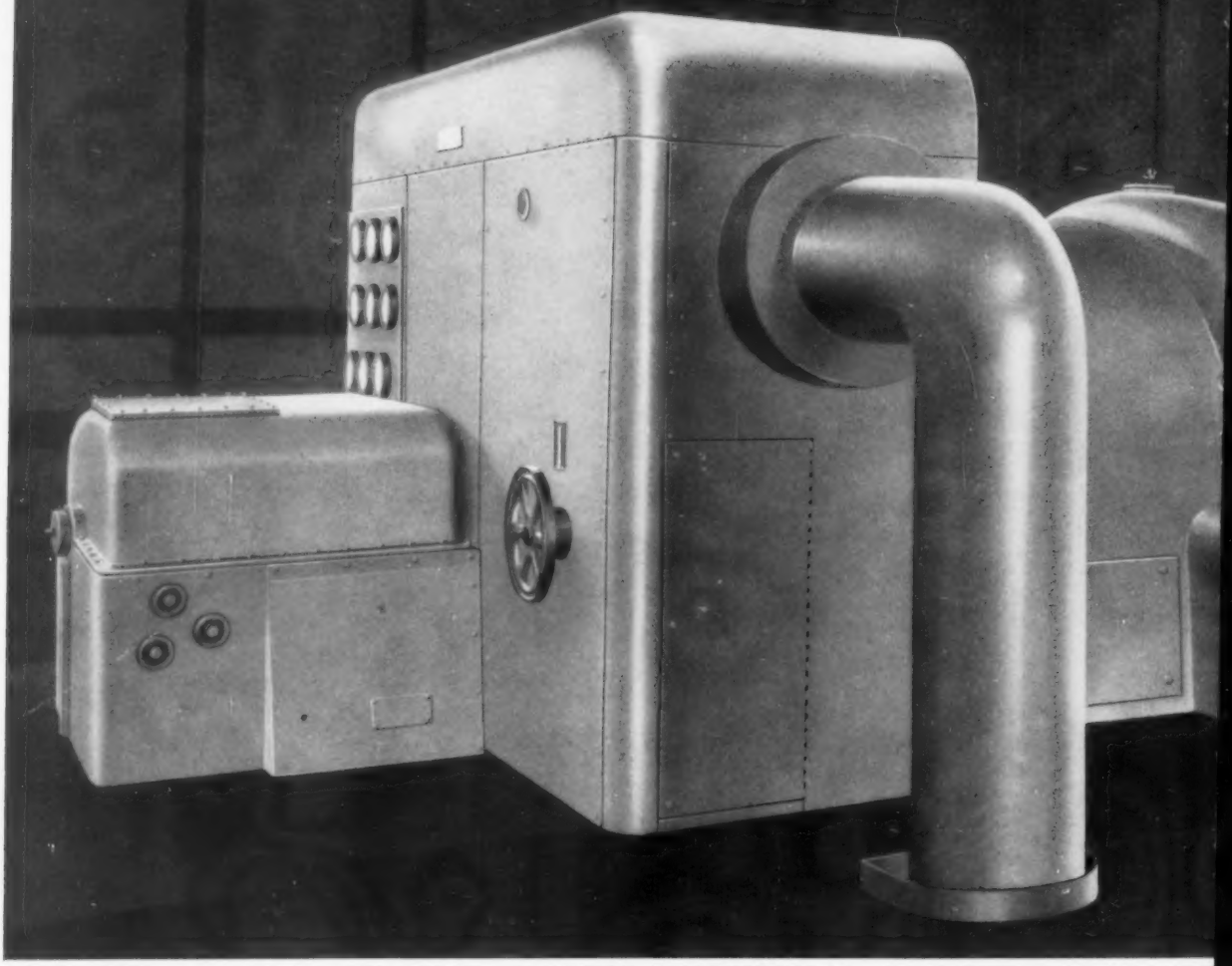
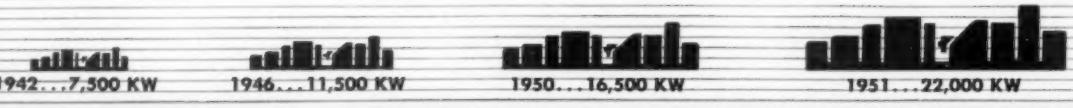
A solid background of TURBINE-GENERATOR





Year after year . . . Elliott turbine-generators are

EXPERIENCE

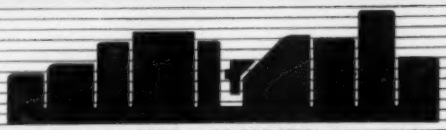
The excellent operation of this 16,500-kw hydrogen-cooled turbine-generator unit is the result of Elliott Company's background of 50 years experience in designing, and building turbine-generator units. The steady march in size ratings is accomplished by a step-by-step introduction of proven components added to each larger size.

Elliott is currently building a 33,000-kw unit and has the facilities, experienced engineers, and craftsmen, to produce size ratings to 44,000 kw. For complete engineering data, call your nearby Elliott district office or write Elliott Company, Steam Turbine Department, Jeannette, Pa.

ELLIOTT Company

HB-4

In this turbine-generator aisle, Elliott has the large machine tool equipment and handling facilities for manufacturing. Under construction is a 33,000-kw unit—designed and built to meet the exact requirements of the user.



1957 . . . 33,000 KW

getting Bigger and Bigger

For more data circle 501 on Post Card

Hall Industrial Water Report

VOLUME 6 JULY 1958 NUMBER 4

Almost 3,000 Billion Gallons of Water

are used each year by the U. S. chemical industry. For all U. S. industry the volume is more than 11,000 billion gallons per year. At this rate industry could drain Lake Erie in eighteen months.

Not all of this water requires treatment but a substantial portion does. Clarification may be all that is necessary for some uses. For others softening, silica removal or alkalinity adjustment may be required. Where very pure water is needed, demineralization may be indicated. Waste water may have to be treated before disposal or to save valuable materials for re-use.

Hall Laboratories has specialized on water problems for over thirty years. Experienced Hall engineers are ready to work with you on your water problems and to help you decide what treating procedures you need in your operations.

Weekly Shutdowns Eliminated

Two boilers in a pesticide manufacturing plant were shut down every weekend for mechanical cleaning. The hard well water used for boiler feed produced scale at a rapid rate despite attempts to prevent this with a "gadget" and later with a cure-all boiler compound.

Then the plant decided to let Hall Laboratories help. The Hall field engineer, with the cooperation of the operating men, soon established conditions in the boiler water which not only prevented new scale formation but removed the old scale at a controlled rate. Now the boilers have operated one year without a shutdown due to scale.

Retubed in Five Months

Three years ago a company operating chemical tank trucks installed a new package boiler for heating and steaming of dirty tanks. Against the recommendation of Hall Laboratories a gadget was purchased to protect the boiler from scale and corrosion.

Five months later a hurry-up call came for a Hall engineer. The boiler had had to be retubed because of corrosion.

Hall engineer M. E. Osmond immediately established water conditions which would protect the boiler. When it was inspected after five months' operation, everyone was pleased to find it clean and free from further corrosion.

The operating men were so impressed that they called on Hall Laboratories again when they ran into trouble. Aluminum tanks, which they were cleaning with a strong caustic soda solution, were corroding. Hall recommended Calgonite® because it is an alkaline detergent which cleans greasy surfaces without attacking aluminum. Once again everyone was pleased when the Hall recommendation solved the problem.

Leaky Baffle Causes Foaming

A Pennsylvania chemical plant suddenly was troubled with severe foaming and carryover of boiler water. When the operators called Hall engineer J. Printz they explained that the trouble was occurring in spite of the fact that the concentrations of phosphate, sulfite, alkalinity and dissolved solids were normal.

Printz collected a sample of boiler water and noticed that it contained a greater amount of suspended solids than normal. He suspected this of causing the foaming.

Why there was so much suspended solids in the boiler water became apparent on investigation. The boiler had operated for awhile with a leak in a furnace baffle which let furnace gases short circuit to the stack without following their normal path through the furnace. This upset circulation in the boiler and permitted sludge to settle out in a section of abnormally slow circulation. The difficulty came after the baffle was repaired when normal circulation stirred up accumulated sludge.

After the boiler was drained and washed to get rid of the sludge, no more carryover occurred.

Special Silica Problem Solved

The Hall engineer was handed a real puzzle when a New England chemical plant asked him to explain why silica deposits were building up in the steam line from a 200-psig pressure boiler and on the diaphragms of the turbine which used the steam. He knew that volatilization of silica in steam does not occur at 200 psig pressure. Something unusual had to be going on. Boiler water silica concentration was normal. The deposits contained small amounts of some salts normally present in boiler water but no phosphate.

A search led to the nitrate converters. In these units water is flashed into steam. This steam at 460°C is introduced to the drum of the 200-psig boiler above the water level. There it mixes with the steam generated in the boiler and goes on to the turbine.

The feedwater to the converters was found to be high in silica. The source of the silica was finally traced to some contaminated condensate from process which was being introduced to the converter feedwater. In a case like this only the experience and training of the Hall engineer enabled him to help the operating men locate the difficulty quickly.

Industrial Water Problems Require Special Handling

There are no "stock answers" to industrial water problems. For information on how the Hall System can help you solve your particular water problems, write, wire or call address below.

Water is your industry's most important raw material. Use it wisely.

HALL LABORATORIES

DIVISION OF HAGAN CHEMICALS & CONTROLS, INC.
HAGAN BUILDING, PITTSBURGH 30, PENNSYLVANIA
DIVISIONS: CALGON COMPANY; HALL LABORATORIES
IN CANADA: HAGAN CORPORATION (CANADA) LIMITED, TORONTO

Hall Laboratories—Consultants on Procurement, Treatment, Use and Disposal of Industrial Water

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PUBLISHED SINCE 1896 FOR POWER ENGINEERS IN PRIVATE AND PUBLIC UTILITIES AND INDUSTRIAL PLANTS

ENGINEERS' PREVIEW

PROJECT EHV is the name for a new 4½-mile extra-high-voltage line, to carry voltages from 600- to 750-kv. The line will be built next year as a prototype transmission system near Pittsfield, Mass., and will be coördinated by the Power Transformer Dept of General Electric.

Other participants in the 5-year program to gain knowledge of EHV transmission are: Western Massachusetts Electric Co, Stone & Webster Engineering Corp, Aluminum Co of America, and a supplier of steel towers. An advisory council representing the electric utility industry will help determine the preferred parameters and areas of study.

Project will cost over $5,000,000, of which more than $600,000 has been appropriated by G-E for land acquisition and preliminary studies. The line will be energized in early 1960.

Plans call for portal-type towers of structural steel, boxed girder construction 10-ft square in cross-section. Highest uprights will be 160 ft and the cross bar 180 ft long. Various conductor sizes in the range from 954 to 1431 MCM will be investigated, using 2, 3 and 4 conductors per phase. For operation in the 600- to 750-kv range, the plan is to use four conductors in a square bundle.

CASE for a 4500-psi industry standard was presented at the recent American Power Conference by Laurence H. Carr and William F. Crawford, respectively director of engineering and research and president of Edward Valves, Inc.

They believe that adopting a new standard now for the extreme-pressure range would mean dollar savings in design and procurement for tomorrow's boilers that go beyond the limits of today's standards.

Survey of prominent engineers in the utility business has revealed an overwhelming preference for the numerically convenient designation of 4500 psi. This is an increase of 80 per cent over the existing 2500-psi class, and just three times the pressure rating of the existing 1500-psi class. Computing allowable pressure at any temperature is simple.

While the proposed 4500-psi class sounds like a very high pressure when pressure alone is considered, Carr and Crawford point out that the pressure-temperature conditions of many modern boilers show that it is far from being an excessively high-pressure design plateau even today. Their conclusion:

"To insist on 'consolidating gains' before going much beyond 3000 psi could unduly restrict valve and piping availability for the pioneer of the near future. Some 95 per cent of the valves required in today's higher pressure power plants can be handled with 2500-psi class valves. But add to the remaining 5 per cent the requirements of petrochemical, refining, hydraulic and other such industries . . . and ample need is found for action on the 4500-psi class today."

WORLD POWER Conference will open in Montreal, Canada, on September 7 at the Queen Elizabeth Hotel, and run through the 11th. This is the first time this international gathering has met in Canada. Fifty-two countries have membership and maintain national committees within the organization. Since the first World Power Conference, held in Great Britain in 1924, 14 plenary and sectional meetings have been held, the most recent in Belgrade last year. At the Montreal meeting, some 150 papers will be presented, geared to the theme, Economic Trends in the Production, Transportation and Utilization of Fuel and Energy. There will be post-conference tours to many points of interest, including the St. Lawrence Seaway and Power Project. General Secretary is T. M. Patterson, director of the Water Resources Branch of Canada's Department of Northern Affairs and National Resources.

The 13th annual Instrument-

Automation Conference and Exhibit will be held in Philadelphia, September 15–19. Instrument Society of America (Pittsburgh) is sponsor. September 17 will be devoted to nuclear energy sessions.

Standards Engineers Society (Camden, N. J.) will meet for its 7th annual conference September 22–24, in Philadelphia.

National Association of Corrosion Engineers announces two regional meetings for October: Northeast region, in Boston, Oct. 6, 7 and 8; South Central region, in New Orleans, Oct. 20–24.

PROSPECT is firming up for U. S. technical and financial assistance to the six European nations which make up the atomic energy group known as Euratom. An agreement in principle has been reached by the U. S. and Euratom whereby atomic power plants can be built by the latter with help from the former. Both sides must now give formal approval.

Euratom has as an immediate objective the construction of atomic power plants with a capacity of 1,000,000 kw by 1961. The U. S. has pledged to arrange a loan to cover one-third to one-half of the estimated $1,350,000,000 cost of this objective.

The agreement also includes research and development assistance from the U. S. in the fabricating of atomic fuel elements, as well as the processing of the elements once they have been used in a reactor.

Also in the area of news on atoms-for-peace is the announcement by Sterling Cole, director general of the International Atomic Energy Agency, that more than 200 fellowships for training in the peaceful uses of atomic energy are available from this agency. The U. S. is offering 120 fellowships during the next two years, while the Soviet Union will accept 25 students for five or six years of study. Candidates from underdeveloped countries will be given preference.

"Have you been repairing metering equipment long?"

CHEAPER GAS, through new gasification processes now being developed at the Midlands Research Station of the British Gas Council near Birmingham, England, is expected to reach a cost of only one-fifth the present price to the consumer.

Powdered coal will be treated under pressure, first with hydrogen to produce by-products and the rich constituent of the final gas. The solid residue from this hydrogenation will then be gasified to completion in oxygen and steam.

Unique feature of this British technique is that the process operates at a pressure of several atmospheres. Pressure inside the vessels in which the gas is made and purified is some hundreds of psi.

This new process will produce three times more gas per ton of coal than the present process of carbonization, the British experts report.

PERSONALS: George A. Orrok, Jr, superintendent of engineering and construction of Boston Edison Co, has been elected a Fellow of American Society of Mechanical Engineers.

T. J. Hull has become executive secretary of the National Association of Corrosion Engineers, succeeding A. B. Campbell, who has retired. Hull has been with NACE since 1952, holds a B.S. in mechanical engineering from the University of Houston. Assistant executive secretary of NACE is R. W. Huff, Jr.

Wayne B. Swift, 30-year-old assistant professor of electrical engineering at the University of Wisconsin, has been awarded the $1000 Kiekhofer Memorial Teaching Award for excellence in teaching. Swift won his B.S. in electrical engineering from the University of Nebraska, his Ph.D. from Wisconsin in 1955.

H. N. Barnard has succeeded A. A. Cummins as president of Cummins & Barnard, Inc, engineers. Cummins takes the title of vice-president.

100,000,000th KW of investor-owned electric company generating capacity went into operation in May, when Tucson Gas, Electric Light & Power Co put a new 75,000-kw generator on line. Further, Edison Electric Institute reports that a record total of 15, 750,000 kw of new generating equipment is being installed this year by the electric utilities, both investor-owned and governmental. Total utility industry generating capacity was 130,356,000 kw at the close of the first quarter in 1958, about double what it was at the end of 1950.

WHO'S WHO? 8th edition of Who's Who in Engineering is scheduled for publication at the end of this year. Engineers Joint Council urges that all those listed in the present (7th) edition mail their replies to the request which has been sent out for up-dating the material. Information that has not been brought up to date will not be reprinted in the new edition. Contact the Editors, Who's Who in Engineering, 265 W. 14th St, New York 11, N. Y.

NEW NAME FOR AGE. American Gas & Electric Co has changed its name to American Electric Power Co. Since the AGE system has not included any sizable gas properties for over 30 years, the new name "more truly describes the service of our company."

CORRECTION: — How About a Central Fuel Committee for Edison Electric Institute? POWER ENGINEERING April 1958, page 83. Readers have doubtless noted the obvious discrepancy in the caption of Table V, a typographical error on our part. The caption of that table should read as follows: Keystone's Predictions of Coal Consumption in the U.S.A. and Exported Coal 1955 to 1970 (Millions of tons). Please make this correction in your copy and accept our red-faced apology.

NEW HEADQUARTERS are announced by: Edison Electric Institute — at 750 Third Ave, New York 17, N. Y.; Morton Salt Co — 110 N. Wacker Drive, Chicago 6.

DE LAVAL
IMO PUMPS

are now more versatile than ever

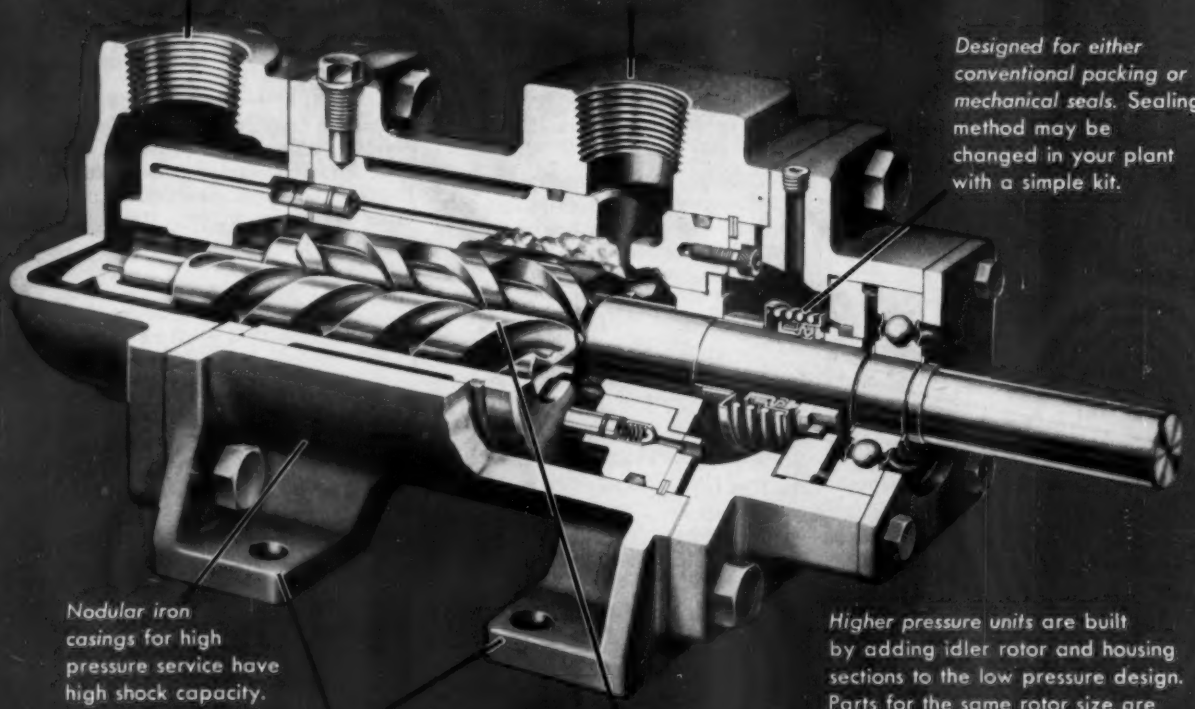
De Laval IMO pumps have proved that they do a dependable job over long years of service. The reason is IMO design simplicity. These constant displacement rotary pumps have only three moving parts—smoothly intermeshing rotors that propel the fluid axially in a steady flow without churning, pocketing or pulsation. There are no timing gears, cams, valves, sliding vanes, or reciprocating parts to wear or become noisy. *Quiet*, compact IMO pumps are excellent for direct-connected, high-speed operation.

In addition to these basic pumping advantages, the improved IMO gives you important new benefits shown in the cutaway illustration below.

Inlet can be rotated to suit installation arrangement.

Discharge flanges are infinitely varied. You can use the most advantageous piping method to suit installation requirements.

DE LAVAL IMO PUMPS can also be used as hydraulic motors.



Designed for either conventional packing or mechanical seals. Sealing method may be changed in your plant with a simple kit.

Nodular iron casings for high pressure service have high shock capacity.

Any position mounting is possible without factory modification.

Higher pressure units are built by adding idler rotor and housing sections to the low pressure design. Parts for the same rotor size are interchangeable over the entire pressure range.

Internal parts are designed as a package so that units can be built into your machines.

Bulletin 3001 gives data on improved De Laval IMO pumps. Send for your copy today.

DE LAVAL *IMO Pumps*

DE LAVAL STEAM TURBINE COMPANY

816 Nottingham Way, Trenton 2, New Jersey

JL 419

WHAT THEY TELL US

▶ **REINJECTION** of fly ash, in most plants, will not improve efficiency but in fact will lower it, according to the experience of A. H. Gesell, Utilities Engineer, Central Generating Plant, in Waupun, Wis. Gesell tells us:

> We have three identical boilers here. We have taken the fly ash from one of these boilers and returned all of it to the wind box, instead of returning it to the boiler. We have been testing coal and experimenting with fly ash and over-fire air all winter, and have come to the conclusion that we are better off by not trying to burn the fly ash.
>
> My contention is that since this fly ash did not burn the first time through, how can you burn it the second time through, after it has a coating of glazed ash covering the carbon?
>
> On a typical day (with 37 deg days and with identical loads on both boilers) the water rate was about 1 lb better on the boiler which was not burning the fly ash than on the boiler in which we were trying to burn it. The average CO_2 on the boiler where the fly ash was going to the wind box was 12.26, while the boiler with the fly ash reinjected was 10.04.

▶ **FROM KHARAGPUR** in India comes a letter from G. A. Rao, who is specializing in power plant engineering at the Indian Institute of Technology. He tells us that

> . . . I am a recent addition to the already bulky overseas readers group. The matter I found in your magazine was so absorbing that in a matter of a few weeks I have gone through all the back numbers of the journal our library could provide.

▶ **INTEREST** in the comparative aspects of American and Russian education is keen. Nathaniel Davies of the U. S. State Dept spoke recently before an ASME section, on Engineering Education in the Soviet Union. Reports Davies:

> On the college level a Russian student spends 27 per cent of his time in general science, and 67 per cent in his field of specialization. Soviet engineering schools also require 5½ years of study compared with the American 4-year college program. While U. S. engineering colleges give the student 3700 to 4000 instruction hours in 22 to 25 subjects before graduation, Soviet engineering schools cram the student with 5200 to 5500 instruction hours in 35 to 40 individual subjects.
>
> In the Soviet Union the study of foreign languages is compulsory. The privilege of college attendance is regulated strictly on the basis of scholastic standing. Straight-A records bring bigger scholarships to the student. The more advanced and specialized a student, the more of a stipend he receives from the State.
>
> Among professors, the more learned get higher salaries and more extras. Full professors in the USSR are paid 16 times the average laborer's wage; in the United States a full professor gets only 2½ times the average laborer's wage.

▶ **OPERATIONAL** savings won this way or that make a theme of interest to everybody. Reader F. M., an institutional power engineer in Wisconsin, tells us that since he installed a spreader stoker . . .

> I have increased steam and reduced coal consumption by 30 per cent.

A. E. K., chief engineer of an institutional plant in California, tells us that the combination of a zone maintenance program and a revamping of his boiler plant resulted in a saving of $18,000 in fuel alone for the year 1956–57. Further . . .

> Use of microbiological cultures in our grease traps and sewage disposal digesters resulted in a saving of approximately $3500 a year.

▶ **NEED** for the availability of data on compressed cylinder gas was pointed up in this department in March by N. C. Stratton, a chemical engineer in Reading, Penna. Now comes this reply from F. R. Fetherston, who is secretary of the Compressed Gas Assn, 11 W 42nd St, New York 36, N. Y.:

> Compressed Gas Assn is an organization with almost 50 years of service to the compressed gas industries. Although there is not a single document that could be referred to as a compressed gas handbook, our Association has published a number of pamphlets on specific compressed gases, and on other subjects of prime interest to our members.
>
> CGA is not a trade association, but it concerns itself with technical matters relating to safety in transportation, storage, handling and use of compressed gases. The Association does not get involved with marketing problems, for obvious reasons.
>
> Our publications are printed primarily for the members of the Association. We are not in the business of selling them, but we do not mind accommodating those who have a sufficient interest to inquire for them. As our organization is not staffed to handle sales of this kind, we ask only that the purchaser obtain an order form from the Association and return it with a remittance to cover such pamphlets as they might require.

▶ **EDWARD B. FELDMAN,** an operating engineer in Duquesne Light Co's Elrama (Pa.) Station, won $300 the other day in prize money in a game featured in a local newspaper. Asked the inevitable question, How did he plan to spend the money, Feldman parried with:

> Just say we have 300 ways to spend those $300. As soon as they hear I've won, everyone wants to divvy up, like the boys at work who are talking about me springing for a party. But you tell 'em we'll do all right by ourselves without help.

▶ **H. W. CAMPBELL,** chief engineer of Interlake Iron Corp of Cleveland, writes concerning a new feature, Introduction to Steam Power, now being serialized in our Handbook department:

> In your May, 1958 issue you started a series of Handbook articles on steam power. Are copies of these articles available and if so, what is the cost? Is the information contained in these articles available in a publication by Commonwealth Edison Co?

As usual, we will be glad to send tear sheets of these articles free of charge to readers requesting them. While the material presented is used by Commonwealth Edison in training power plant operators, it is not now available from the company in published form.

▶ **MOLYBDENUM DISULFIDE'S** properties as a lubricant, as presented in an article in our March issue (pages 60–62), have stirred up lively interest. Zell G. McGee, president of McGee Chemical Co, makers of the product, tells us he has received scores of inquiries from readers of the article,

> . . . which bears out our appraisal of the splendid job you did in presenting your article. Furthermore, it is to be noted that practically all of these inquiries are coming from the biggest names in American industry.

Maintenance and Steam Traps

. . . there's a relationship that goes far beyond trap maintenance alone

Good traps and good trapping have a greater effect on your maintenance costs than does trap maintenance itself. By that we mean that the right traps, properly selected and installed, and with the benefits of a preventive maintenance program, will save far more maintenance dollars than they will cost.

Under the pressure of spiralling maintenance costs, this thought becomes mighty important. Let's take a look at what it involves:

Proper Selection of Steam Traps

1. Be sure it's the right type of trap.

2. Be sure it's sized right and is for the correct operating pressure.

3. Be sure it's first rate in design and construction.

Proper Installation of Steam Traps

1. Install them so they are accessible for inspection and maintenance.

2. Install a test valve.

3. Use a union or unions.

4. Use a shutoff valve or valves.

5. Use a strainer ahead of the trap if dirt conditions are bad.

6. Use a by-pass only where continuity of service is imperative.

7. Standardize inlet and outlet connections.

Preventive Maintenance Program

1. Test trap regularly for proper operation. (Trap size, operating pressure and importance determine frequency.)

2. Inspect internal mechanism at least once a year.

You Get Indirect Benefits As Well

The direct benefits of the plan outlined are pretty obvious — good traps, properly selected, require less maintenance . . . testing and inspection prevents troubles that lead to maintenance.

However, this plan provides indirect benefits which reduce maintenance in other parts of the plant as well:

Good traps save steam and reduce the load (and consequently maintenance) on fuel handling and burning equipment and on ash handling equipment.

Good traps protect the system by eliminating water hammer and preventing the damage it can do.

Good traps discharge carbon dioxide before it can go into solution to form corrosive carbonic acid — less corrosion, less maintenance.

Good traps increase production to reduce the length of time equipment must operate or reduce the amount of equipment needed . . . either way maintenance is reduced.

How to Go About It (The Sales Pitch)

We admit we're prejudiced, but we don't think there is any better way to select steam traps than with the help of the 44 page Armstrong Steam Trap Book. Here in a single source is specific data on the selection and sizing of traps, how to install them for best results, and how to maintain them most economically.

The Steam Trap Book will also give you full information on the design and construction of Armstrong Inverted Bucket Steam Traps that offer these important maintenance-reducing advantages:

1. Armstrong Traps are dependable.

2. Armstrong Traps require no adjustments — go from full load to zero load automatically.

3. Armstrong Traps are self-scrubbing—ordinary dirt conditions can't hurt them.

4. Armstrong Traps have long-life parts — valve and seat are heat treated chrome steel — lever assembly and bucket are stainless steel.

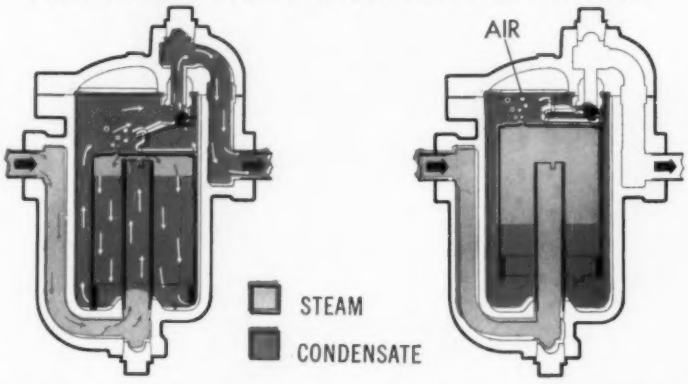
5. Armstrong Traps have water sealed valves to minimize wire drawing and erosion.

Ask for your copy of the Steam Trap Book—there is no obligation. Then test Armstrong Trapping. If you are not completely satisfied with the results, you can return the traps for a full refund of the purchase price. You can't lose much that way. Call your local Armstrong Representative or Distributor, or write

Armstrong Machine Works
8101 Maple Street
Three Rivers, Michigan

ARMSTRONG STEAM TRAPS

HERE'S THE STEAM TRAP DESIGN
THAT CAN REDUCE YOUR MAINTENANCE PROBLEMS



Trap open. Condensate entering trap has caused bucket to lose buoyancy. Weight of bucket times leverage pulls valve open. Air is discharged along with condensate.

Trap closed. Steam has floated inverted bucket; valve is held tightly closed by system pressure. Air entering trap passes through bucket vent and accumulates at top of trap.

For more data circle 504 on Post Card

here is what you need for *better* BOILER WATER LEVEL INDICATION!

YARWAY REMOTE LIQUID LEVEL INDICATORS

Boiler water levels and other liquid levels requiring remote indication can be handled completely by a Yarway system.

Heart of the system is the Yarway Remote Liquid Level Indicator that gives instant, accurate readings because the mechanism is operated by the boiler water or other liquid itself. The pointer mechanism is never under pressure. Clear, "wide vision" face permits easy readings from any angle.

The Yarway Indicator conforms with A.S.M.E. Boiler Code Committee ruling (Case #1155) permitting two independent remote level indicators of compensated manometric type to replace one of two required gage glasses for boiler pressures 900 psi and above.

Electronic Secondary Indicators can be added at any point in the plant. Remote Hi-Lo Alarm Signals (lights and/or horns) can be connected for additional safety.

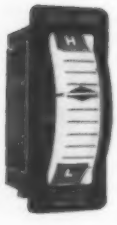
Primary indicators fully compensated for every pressure change in boiler also available.

For permanent record of changing levels, the Yarway Hi-Lo-Graph Recorder can be furnished.

Over 12,000 Yarway Remote Indicators have already been installed. For full details, write for Yarway Bulletin WG-1824.

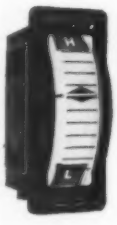
YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
Branch Offices in Principal Cities

FULLY COMPENSATED INDICATORS



for completely accurate indication under every boiler operating condition.

ELECTRONIC SECONDARY INDICATORS



To supply additional indication at any point without pressure connections.

REMOTE SIGNALS

Hi-Lo Alarms. Lights and/or Horns.

RECORDERS

To provide permanent 24-hour record of liquid levels.

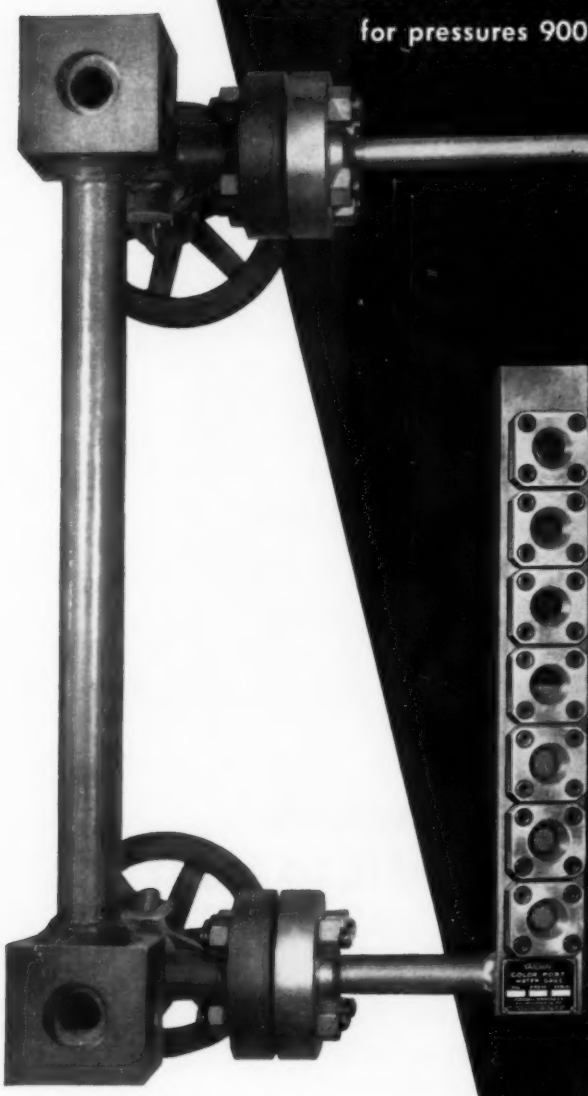
YARWAY

. . . a good way to specify remote liquid level indicators

COLOR-PORT

BOILER WATER LEVEL GAGE

for pressures 900 to 3000 psi

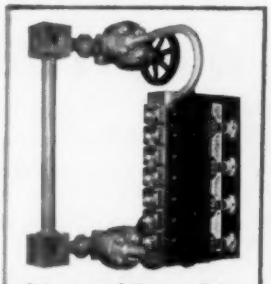


- *two-color readings!*
- *reduced maintenance!*
- *increased availability!*

Now Yarway offers brilliant two-color boiler water level readings, combined with simplicity of gage maintenance and increased availability.

With the new Yarway Color-Port Gage, water space shows green, steam space shows red. A full gage is all green and an empty gage all red.

The Color-Port Gage is *serviced quickly in place* by simple replacement of individual cover-glass assemblies. Each cover assembly is held solidly in place by four socket head capscrews and the "floating assembly" design applies safe predetermined loads on glass ports, reducing thermal shocks, and permitting faster warm-up. *Increased availability means longer service life.*



Side view of Yarway Color-Port Water Level Gage with illuminator, circulating tie-bar and Welbond gage valves.

Write today for new Bulletin WG-1814, completely describing Yarway Color-Port High Pressure Water Level Gages.

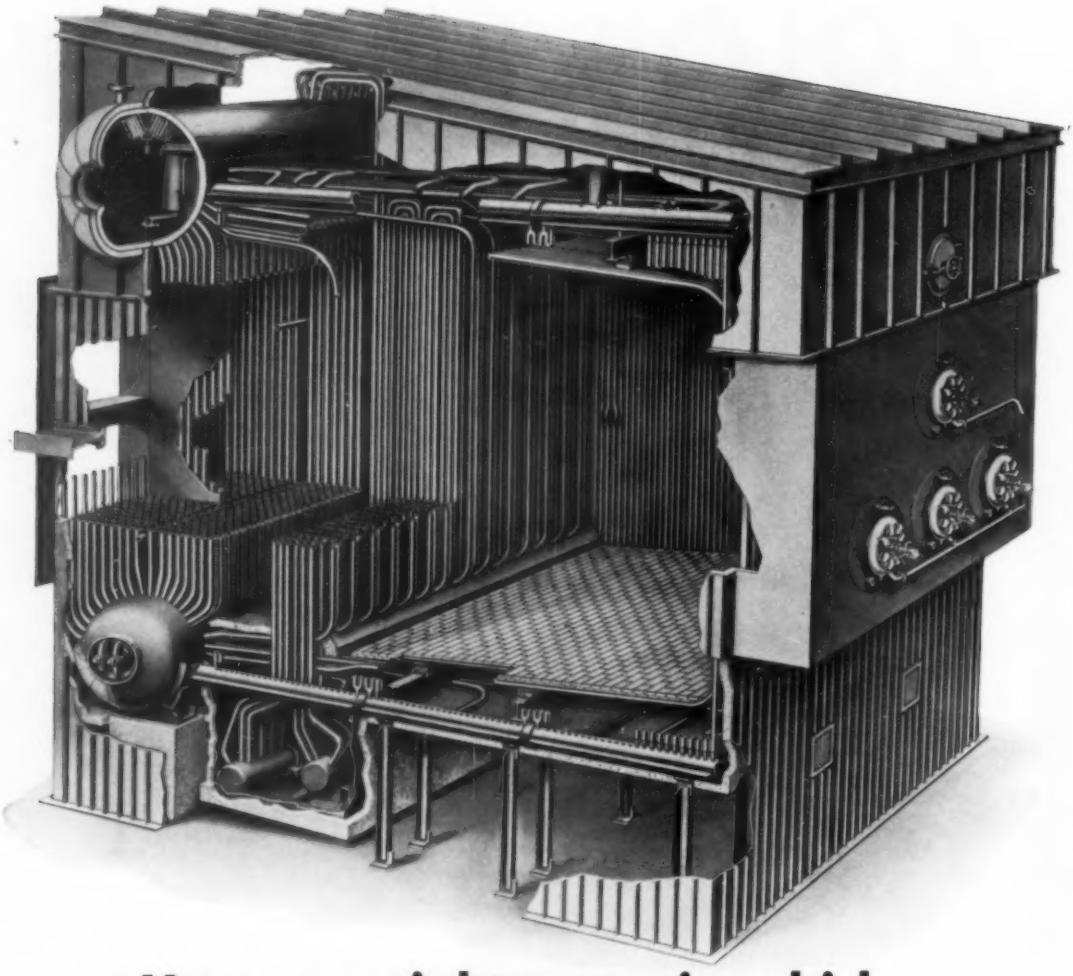
YARNALL-WARING COMPANY

100 Mermaid Avenue, Philadelphia 18, Penna.

BRANCH OFFICES IN PRINCIPAL CITIES.

YARWAY COLOR-PORT ... *a good way to specify high pressure water gages*

For more data circle 505 on Post Card



Here are eight ways in which the PFI Boiler can be of benefit to you:

1. It requires a minimum amount of space for a given power output.
2. The pressurized furnace design assures economy by eliminating the induced draft fan and air infiltration. This means savings in cost of fans, fuel, and operating power.
3. Pre-assembly of many of the components of the PFI Boiler is controlled in B&W shops, resulting in a reduction of the time and manpower required for field erection.
4. The PFI is designed to burn oil, gas, or a combination of the two. When it is equipped with a dual-fuel burner, it allows you to take advantage of favorable market conditions.
5. Cyclone Steam Separators ensure adequate water circulation which protects boiler tubes from overheating, even with wide and frequent changes in load. They also give you clean, dry steam at all designed ratings with high boiler water concentrations.
6. The drainable superheater design assures quick, safe start-up and ease of storage.
7. Water-Cooled Burner Throat eliminates troublesome maintenance, costly repairs.
8. All-welded Membrane Wall contributes to high efficiency and reduces insulation requirements.

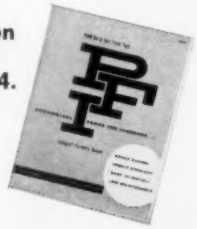
Announcing New, Economical Power for Industry

New B&W PFI Oil-Gas Burning Unit Provides Maximum Output in Minimum Space

Here's an answer to industry's need for an economical, dependable steam supply. The new B&W Integral-Furnace Boiler produces high-quality, dependable steam economically at all ratings. Aptly named the PFI, the "Power For Industry" Boiler is compact, easy to install, quick to meet rapid and wide load swings. The new boiler gives long, sustained operation, requires little attention and is readily accessible for inspection, cleaning and maintenance.

All responsibility for your complete delivered and erected unit is accepted by one experienced, dependable source which in the past 25 years alone has placed over 4,000 Integral-Furnace Boilers in service. Behind *every* B&W Boiler is nearly a century of leadership in steam generation. A national network of B&W plants and engineering facilities means that the special skills of B&W engineers are always quickly available to you for service and assistance. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

For further information about the B&W PFI Boiler, write for Bulletin G-94.

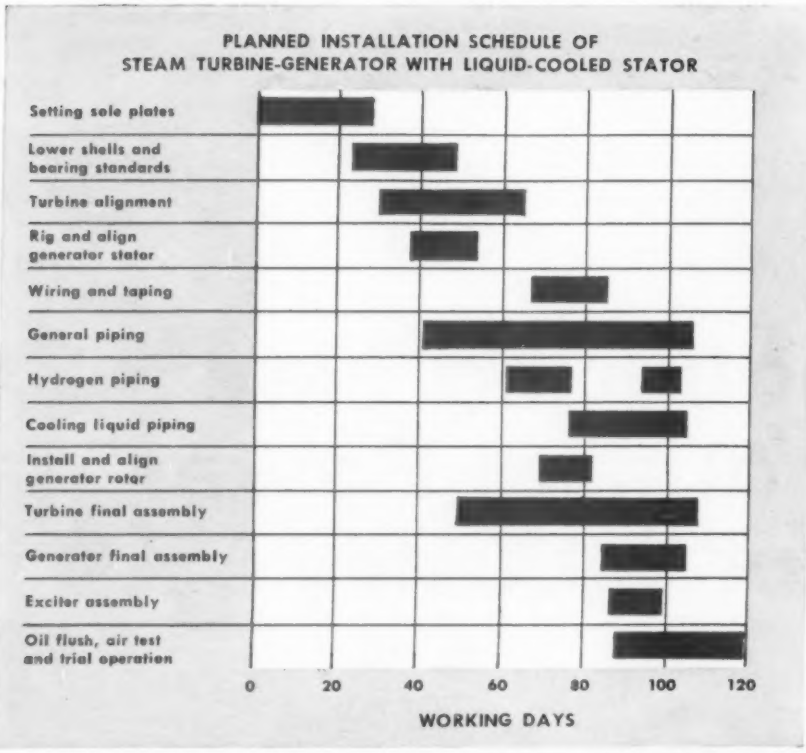


BABCOCK & WILCOX

BOILER DIVISION

G-892A-IF

For more data circle 506 on Post Card

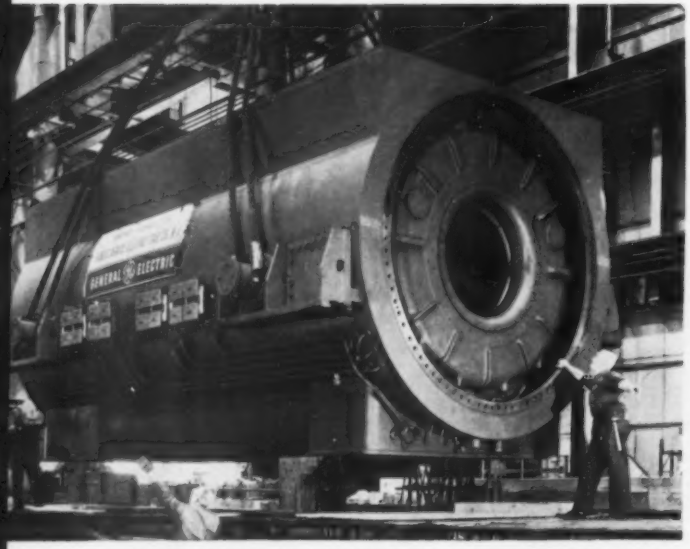


INSTALLATION TIME of liquid-cooled generators approximates time cycles established for conventionally-cooled units. Because of the simplicity of these units, no special assembly techniques are required.

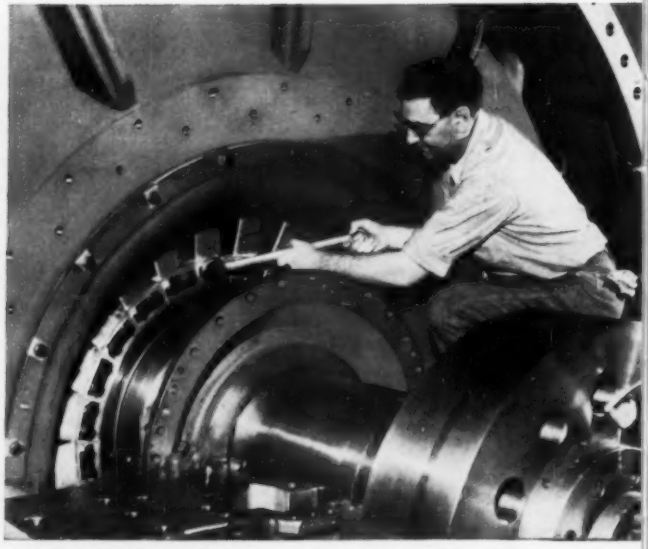
INSERTION OF ROTOR into liquid-cooled stator is accomplished with the same ease as for conventionally-cooled units.

WITH HIGHER RATINGS NOW POSSIBLE FOR GENERAL ELECTRIC GENERATORS...

Simplicity of direct cooling components



A SINGLE CRANE LIFT can handle this typical 291,000 kva liquid-cooled generator stator. The smaller size and lighter weight of these units are important shipping and installation considerations.



SINGLE-STAGE, AXIAL-FLOW FAN, inner end shield and fan nozzle ring are quite accessible. Complicated end shields and multi-stage fans are not needed on liquid-cooled generators.

speeds assembly, increases availability

SINGLE-STAGE, LOW-PRESSURE FAN ASSEMBLY IMPROVES ROTOR ACCESSIBILITY

The successful application of liquid cooling to generator stators has made possible tremendous increases in unit ratings—yet, with all their advantages, these generators have retained the basic design simplicity found in conventionally-cooled units.

Rotor assembly, for example, is considerably simplified for these higher-rated units. Since liquid cooling eliminates requirements for multi-stage fans and complicated end-shield assemblies, labor assembly costs and inspection downtime are reduced.

Equally important, the increased output possible with liquid cooling means that, on a per kw basis, components are relatively smaller and weigh less. This consideration reflects savings in shipping and handling costs and supporting foundation mass.

Ease of assembly and disassembly is just one of the many important advantages of General Electric liquid-cooled generators. Other outstanding features are:

Increased Generator Output—*Hollow-strand stator bar construction can remove up to 16 times more heat than conventional cooling arrangements, permitting higher generator ratings.*

Improved Performance—*Liquid cooling permits automatic regulation of stator winding temperature independent of load.*

Dependable Operation—*Many unique features are incorporated into the design of the closed coolant system to provide a permanently tight liquid circuit.*

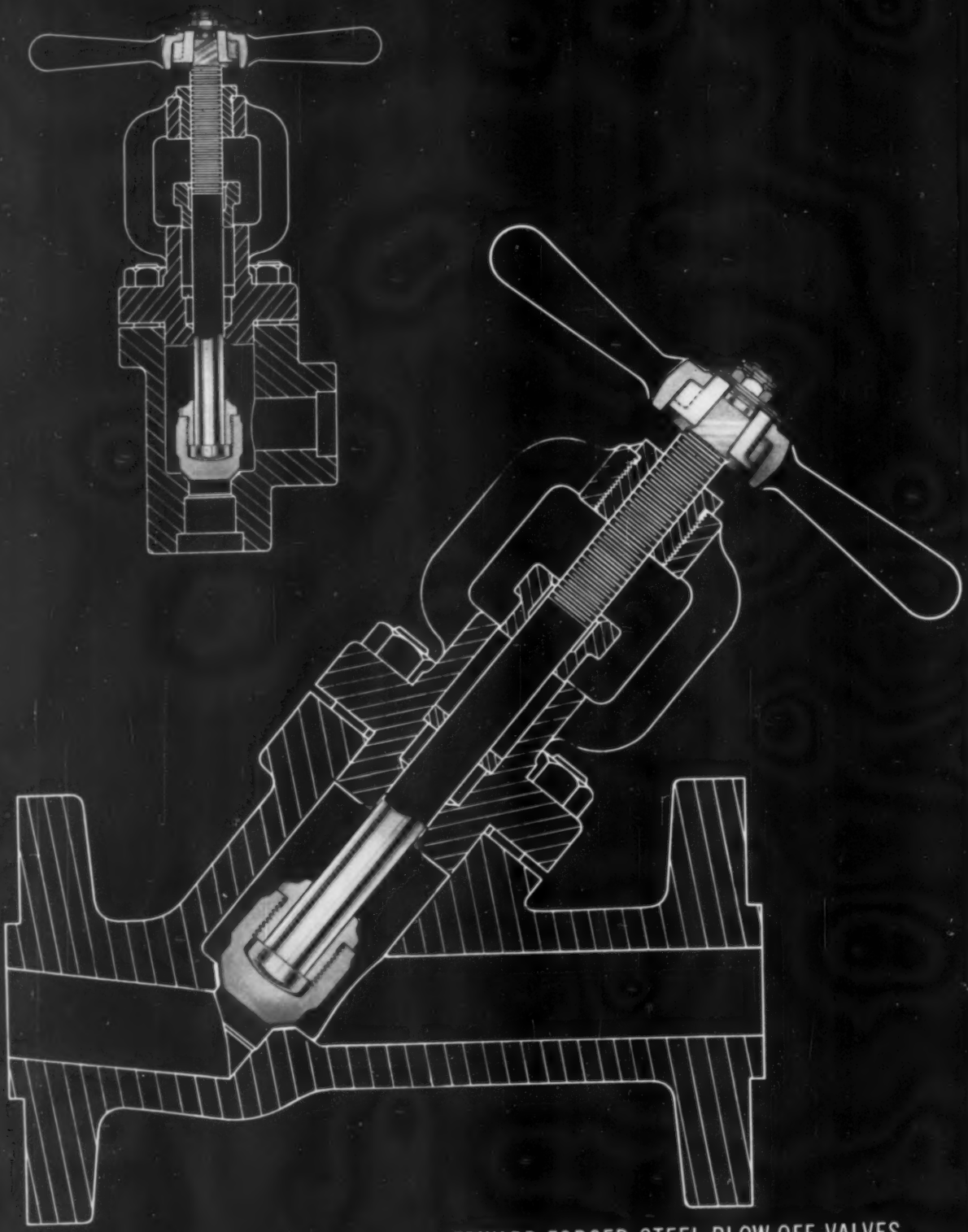
Design Simplicity—*Dielectric system maintains the simplicity and dependability of conventionally-cooled machines.*

For more information on liquid cooling, contact your nearest Apparatus Sales Office or write to Section 254-73 for bulletin GER-1231, Large Steam Turbine-Generator Department, General Electric Company, Schenectady 5, New York.

Progress Is Our Most Important Product

GENERAL ELECTRIC

For more data circle 507 on Post Card



EDWARD FORGED STEEL BLOW-OFF VALVES

What's New from Edward Valves

New Products . . . Problems and Solutions. . . Information on Steel Valves from Edward, Long-Time Leader in the Field!

Edward Drop Forged Blow-off Valves

. . . the first—and still the newest!

Fifty years ago, when boilers operated at 250 lb sp the first really efficient means of blowing-down was with "new" Edward blow-off valves. Today, with pressure in the 1800-2600 lb range and with water temperatures sometimes exceeding 600 F, corresponding improvements in Edward blow-off valves have been effected. For example, today all Edward blow-off valves have integral Stellite seats and Impactor* easy closing handles.

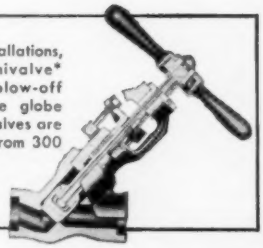
All over the world, high temperature-pressure steam power stations rely on these Rockwell-built Edward blow-off valves. The reasons are basic. Edward valves are simple and rugged in design, with no "trick construction." They operate easily, stay tight, need very little maintenance. If parts replacement is ever necessary, repairs are easier and less expensive than with any comparable valve.

The ASME Power Boiler Code requires steel valves wherever boiler drum pressure is above 200 psi . . . but, because blow-off service is severe at any pressure, operators of lower-pressure plants also have found it most economical to standardize on Edward valves.

Catalog 12-D2 tells the full story.

Recommended practice: Open valve *nearer* boiler first. Then slowly open other valve. After blow-off, close second valve first; then valve nearer boiler. This places greatest wear on blowing valve, assures a tight valve next to boiler, facilitates repair without a boiler shut-down.

Popular for high pressure installations, the Edward welded-bonnet Univalve* meets Code requirements for blow-off service and is ideal all-purpose globe valve as well. Edward blow-off valves are available in all pressure classes from 300 lb to 2500 lb in angle or straight-way styles, with flanged or welding ends.



Premium Features of Edward Blow-off Valves

- INTEGRAL SEAT of chromium-cobalt-tungsten alloy. Applied directly to body in a continuous ring, then machined in same set-up with bonnet guide bore for perfect alignment. Highly resistant to abrasion and corrosion.
- HARD-FACED DISK—Stellited for maximum resistance to abrasion and corrosion. Edward swivel-disk construction allows stem to lift vertically away from seat. No grinding or galling.
- POSITIVE BACKSEAT isolates packing from the high temperature zone. Line-contact backseat seals EValpak* valve packing from line pressure, permits repacking under pressure.
- IMPACTOR HANDLE, an Edward exclusive, is standard equipment. Several times more effective than ordinary handles or handwheels in opening or closing valves.

EDWARD VALVES, INC.

1202 West 145th Street, East Chicago, Indiana

Subsidiary of

ROCKWELL MANUFACTURING COMPANY

Represented in Canada by

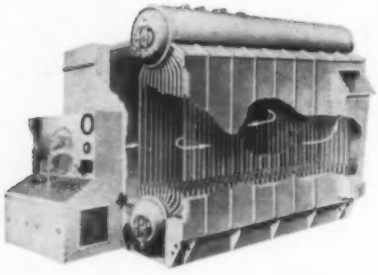
LYTLE ENGINEERING SPECIALTIES, LTD., 360 Notre Dame St. W., Montreal 1, Que.

Edward builds a complete line of forged and cast steel valves from ⅛" to 18"; in globe and angle stop, gate, non-return, check, blow-off, stop-check, relief, hydraulic, gage and special designs; for pressures up to 10,000 lbs; with pressure-seal, bolted, union or welded bonnets; with screwed, welding or flanged ends.

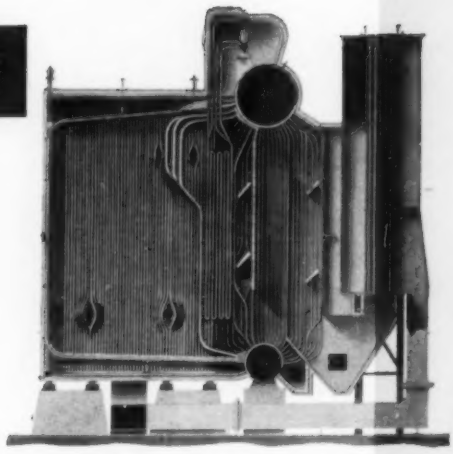
*T. M. Reg. U. S. Pat Off.

For more data circle 508 on Post Card

OIL AND GAS FIRED BOILERS
(standardized designs)



C-E Package Boiler, Type VP — Completely shop assembled . . . available in 14 sizes from 4,000 to 50,000 lb of steam per hr capacity . . . pressures to 500 psi. Available with integral console control panel. This unit contains more water-cooled area per cubic foot of furnace volume than any other boiler of its size and type.



C-E Vertical-Unit Boiler, Type VU-55 — Available in six sizes . . . capacities from 50,000 to 120,000 lb of steam per hour . . . designed for three pressure ranges, 250 psi, 500 psi and 750 psi, and steam temperatures up to 750 F. Equipped with tangential burners. 60-inch steam drum assures generous water capacity and steam reservoir space. Tangent tube waterwalls offer complete furnace protection, minimizing maintenance.

MODERN INDUSTRIAL

C-E offers the most advanced steam generating in any size . . . for any fuel . . . with any method

All the designs pictured here have something in common. All are evolved from a basic design concept — a 2-drum, vertical boiler with fully water-cooled furnace in front of the boiler proper — a design which Combustion Engineering originated more than 30 years ago and which has enjoyed the widest acceptance.

All are fully integrated designs comprising boiler, furnace, fuel-burning and, where required, superheat and heat-recovery equipment, coordinated into a smoothly functioning unit.

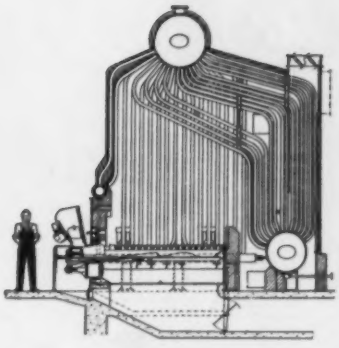
All have benefited from C-E's experience in meeting the most exacting standards in steam generation — those of the electric utility industry for which C-E is currently designing and building boilers which will set tomorrow's standards of capacity, pressure and temperature.

All have demonstrated — in many installations — high standards of performance . . . economy, reliability and suitability for the particular fuel and operating conditions for which they were selected.

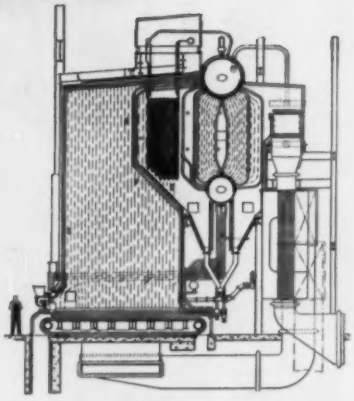
So — no matter what combination of conditions prevail at your plant, Combustion has a boiler unit that can meet your requirement, exactly — and economically. We'd like to discuss it with you and your consultants.

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS;

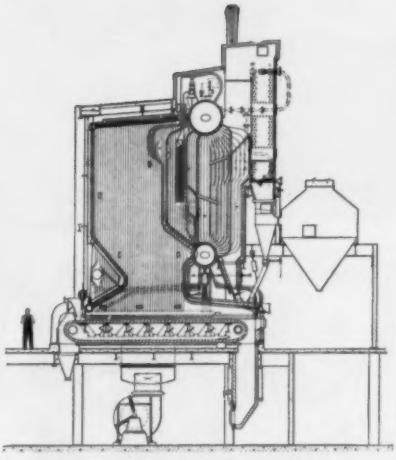
STOKER FIRED BOILERS*



C-E Vertical-Unit Boiler, Type VU-10 — fired by a C-E Underfeed Stoker, Type E — VU-10 Boilers are available for capacities from 10,000 to 60,000 lb of steam per hr with pressures to 475 psi; superheat to 200 F in larger sizes. Also can be equipped with C-E Spreader Stokers, dump grate type.



C-E Vertical-Unit Boiler, Type VU-40 — fired by C-E Spreader Stoker, continuous discharge type — A baffleless boiler with capacities ranging up to about 300,000 lb of steam per hr, with pressures to 1,200 psi; temperatures to 950 F

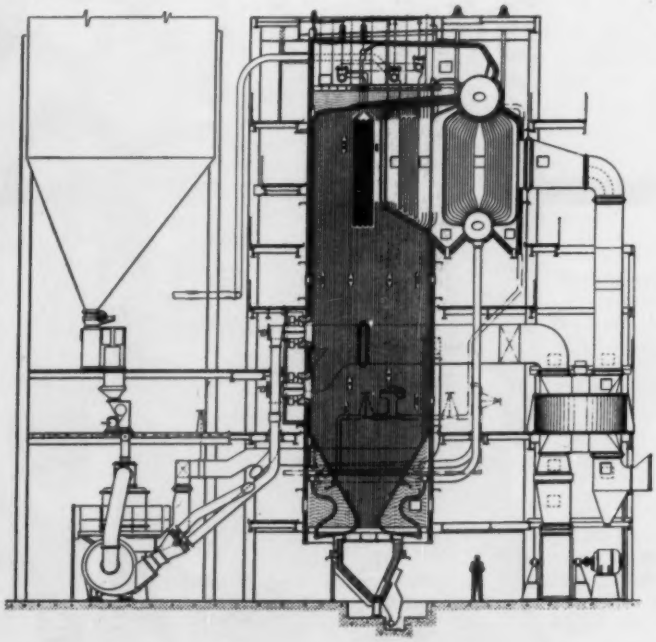


C-E Vertical-Unit Boiler, Type VU-50 — fired by C-E Traveling Grate Stoker — Units of this design are suitable for capacities up to about 150,000 lb of steam per hr; pressures to 1,200 psi; temperatures to 950 F.

BOILERS

equipment of firing

PULVERIZED COAL FIRED BOILERS*



C-E Vertical-Unit Boiler, Type VU-40 — using C-E Raymond Bowl Mills and Horizontal Burners — Capacities up to 600,000 lb of steam per hr, pressures to 1,200 psi, temperatures to 950 F.

These drawings are a few examples of the many units available for coal firing: all are readily adaptable to oil or gas firing.

COMBUSTION ENGINEERING

Combustion Engineering Building • 200 Madison Avenue, New York 16, N. Y.

Canada: Combustion Engineering-Superheater Ltd.

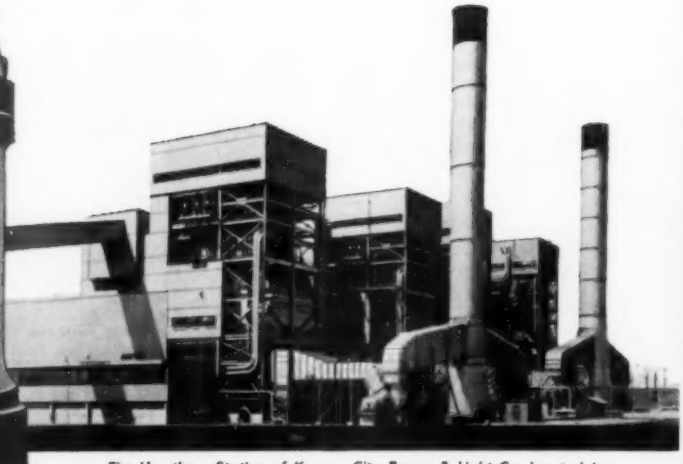
C-139

PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

For more data circle 509 on Post Card

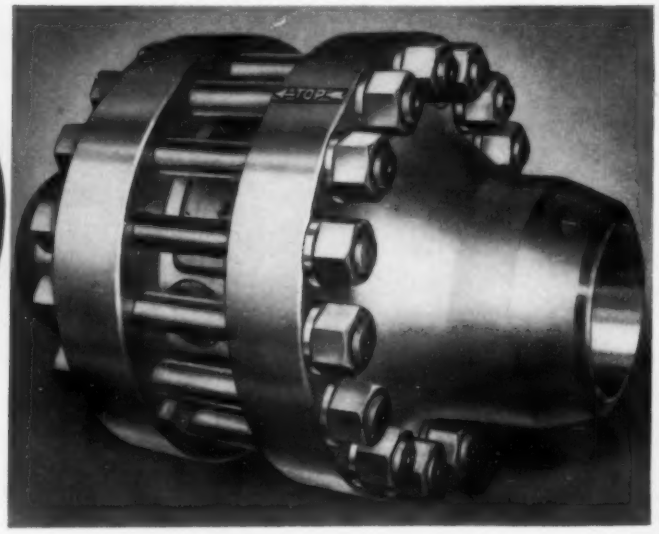
Under pressures from 2500# to 150# psi . . .

Typical of the Chapman 2500# psi alloy steel valves used in Kansas City. Has welded body and bonnet connection and is equipped for motor operation.



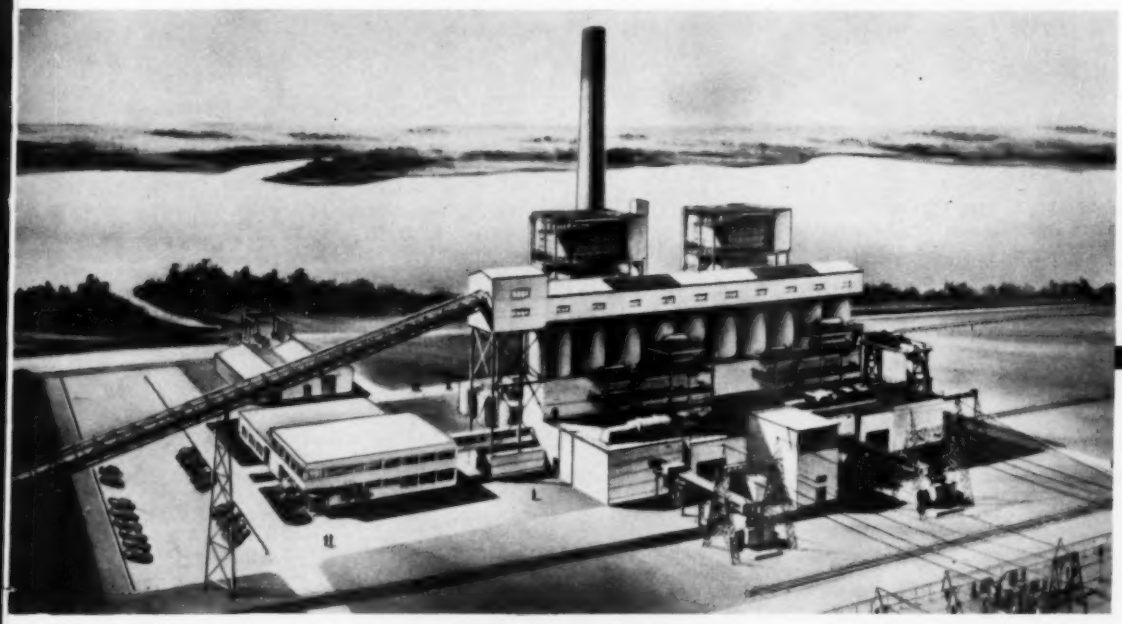
The Hawthorn Station of Kansas City Power & Light Co. located in Kansas City, Mo.

Chapman 3-piece tilting disc check valve with welding ends.



CHAPMAN VALVES

are doing a job for Kansas City Power & Light Co.



(Left) New Montrose Station, located 60 miles Southeast of Kansas City.

Ebasco Services Incorporated, acted as Engineers and Construction Managers for Kansas City Power & Light Co.

Here's a good example of what Chapman Valves can do for power plants.

In the Kansas City power plants, pressure requirements are varied . . . from 2500# to 150# psi. And Chapman Valves are meeting the specified pressure-temperature ratings . . . Chapman alloy steel gate, globe, swing check and tilting disc check valves . . . Chapman Valves, both hand and motor operated . . . Chapman Valves with welded body and bonnet or pressure seal.

In Kansas City, you'll find Chapman Valves in the 332,000 KW Hawthorn Station. You'll find them in the first brand new 156,250 KW unit at Montrose Station. You'll find them in the second Montrose unit scheduled for completion in 1960.

The reason for all this makes an interesting story. Chapman goes all out . . . 100 per cent . . . to meet valve requirements in a true engineering way. Upon request, one of our engineers will gladly talk to you about it.

The **CHAPMAN** *Valve Manufacturing Co.*

INDIAN ORCHARD, MASSACHUSETTS

For over 75 years, Chapman has been designing, developing, improving, building, testing and delivering valves to meet usual and special requirements for power plants, water works, chemical plants, refineries and industrial use.

For more data circle 510 on Post Card

DECIDING ON AIRFOIL?

INSIST ON "BUFFALO"

Mechanical Efficiency up to a True 92%

MAXIMUM FORCED-DRAFT PERFORMANCE UNDER SPECIFIC CONDITIONS

WHEN YOU INSIST ON "BUFFALO" AIRFOIL FANS you immediately find many important factors in your favor. "Buffalo" Airfoils give you *true* mechanical efficiencies up to 92%. Main point here is that "Buffalo" Airfoil Fans will positively *live-up* to their ratings. They are designed, engineered, built and tested to deliver these peak efficiency ratings. You can *rely* on "Buffalo" Airfoils to meet your performance specifications.

There are sound engineering "reasons why" behind the proven performance of "Buffalo" Airfoil Fans. "Buffalo" offers unique, deep-blade airfoil design plus a brand new approach to streamlining. Turbulence is reduced to an absolute minimum because of the smooth inlet bell — the matching curved wheel flange — the new "Buffalo" divergent outlet. And with "Buffalo", you get more than an airfoil fan — you can choose from a *complete line* of airfoil and semi-airfoil wheels, to give you maximum efficiency for your precise operating conditions.

Whichever "Buffalo" Fan *you* select as best-suited to your operation . . . you're sure of getting the famous, rugged, dependable, long-lasting construction that's been an integral part of every "Buffalo" product for more than 80 years. We call it the "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.

For the Finest in Mechanical Draft Service, Write Us now for Bulletins FD 106, FD 205, and F 200.

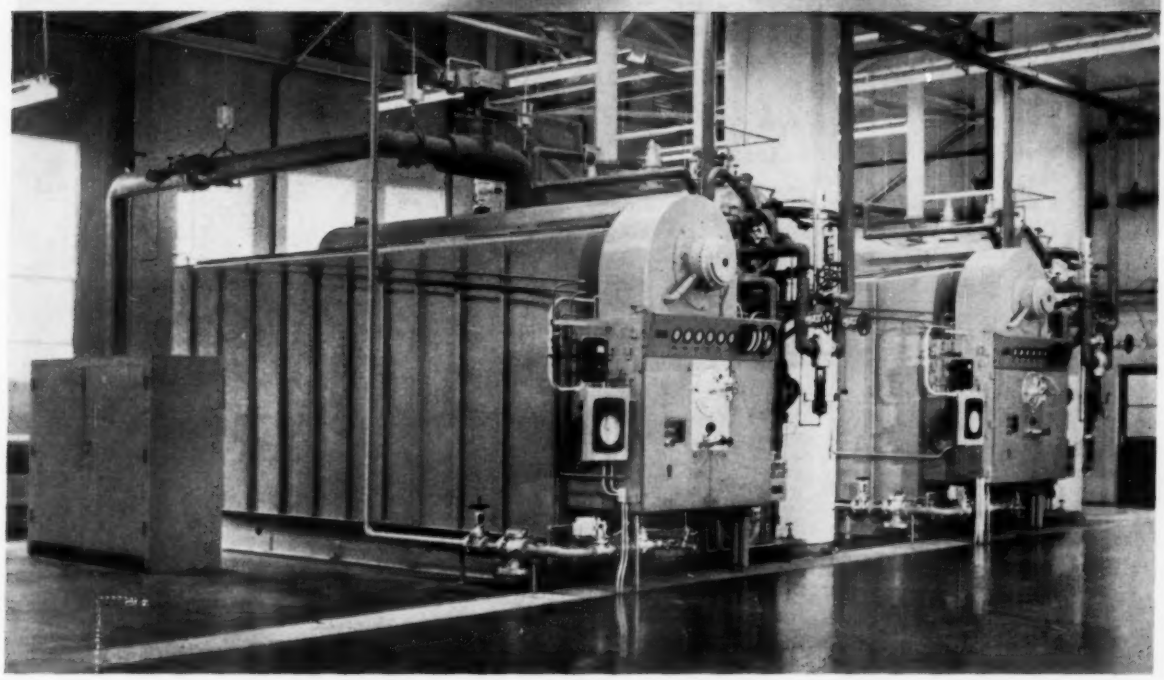
BUFFALO FORGE COMPANY
BUFFALO, N. Y.
Canadian Blower & Forge Co., Ltd., Kitchener, Ont

"Buffalo"

VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT EXHAUSTING FORCED DRAFT COOLING HEATING PRESSURE BLOWING

For more data circle 511 on Post Card

PACKAGED STEAM
by Foster Wheeler
at BOEING DEVELOPMENT CENTER



Two 34,000 lb/hr Packaged Steam Generators supply heating and process load at aircraft and missile research center

In the boiler room at Boeing Aircraft Company's new development center in Seattle, Washington, the two Foster Wheeler AG-134 Packaged Steam Generators shown above provide ample capacity for both present and future loads.

Each unit has a guaranteed rating of 34,000 lb/hr at 250 lb design pressure and 150 lb working pressure with oil firing. When firing natural gas, the output is 32,000 lb/hr.

Shipped completely assembled from Foster Wheeler's Dansville, N. Y. plant, they were installed on simple slab foundations. Each unit is equipped with semi-automatic combustion controls and a 44-inch self-supporting stack. The 36-inch steam drum includes a baffled steam collector, piping for feedwater distribution, continuous and surface blowoff. Staggered boiler bank tubes and closely spaced waterwall tubes contribute to high efficiency while large furnace volume provides conservative rates of heat liberation.

FW Packaged Steam Generators are now available in capacities from 10,000 to more than 60,000 pounds per hour. For complete information, write to *Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, N. Y.*

FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

For more data circle 512 on Post Card

Wing Draft Inducers

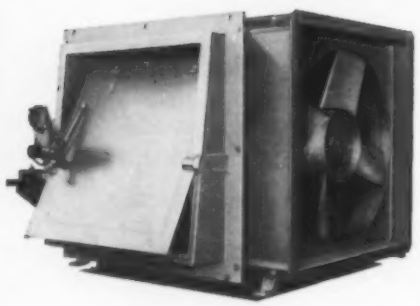
FIRST IN SALES IN NORTH AMERICA BECAUSE:

EASY TO INSTALL
Three inlet openings and interchangeable mounting feet meet any installation requirement. Inducer may be mounted for either horizontal, vertical or angular discharge, and can serve one or more boilers.

AXIAL FLOW FAN
All welded steel fan wheel of airfoil design and non-overloading, low horsepower characteristics permit maximum, unrestricted gas flow of natural draft.

RUGGED CONSTRUCTION
Wing Draft Inducers are sturdily and compactly constructed for long, trouble-free life.

EXPLODED VIEW
showing inner assembly partially withdrawn.



Discharge end of Inducer showing optional barometric damper.

WC 114

Cost Less than smokestacks.

Cost Less by eliminating high stack maintenance costs.

Cut fuel costs and improve boiler operation by always providing the correct draft for complete, economical, safe, and smoke-free combustion.

Improve appearance.
Eliminate tall, ugly stacks. Low stub stacks harmonize best with modern architecture.

EASY TO SERVICE
Entire fan and inner bearing assembly is easily withdrawn from the casing—out of the hot gas stream—when desired.

NO LUBRICATION NEEDED
Sealed type bearings require no lubrication. Unique Wing design draws cooling air through insulated shaft tube protecting bearings from flue gas temperatures, even as high as 750°F.

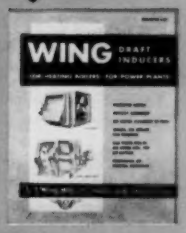
QUIET OPERATION
Ideally suited for use in schools, churches, hospitals, etc.

TROUBLE-FREE DRIVE
V-belt drive eliminates the need for field alignment. Belt tension is automatically maintained by a spring-loaded base.

PRECISE DRAFT CONTROL
Fan speeds are adjustable with either variable speed motors or with adjustable pitch sheaves and constant speed motors. Turbine drive also available.

PROVED DEPENDABILITY
Thousands of successful installations. Standard with most boiler manufacturers.

For detailed information on how Wing Draft Inducers can give you lowered installed costs, lower fuel costs, and reliable operation, write for Bulletin I-58.

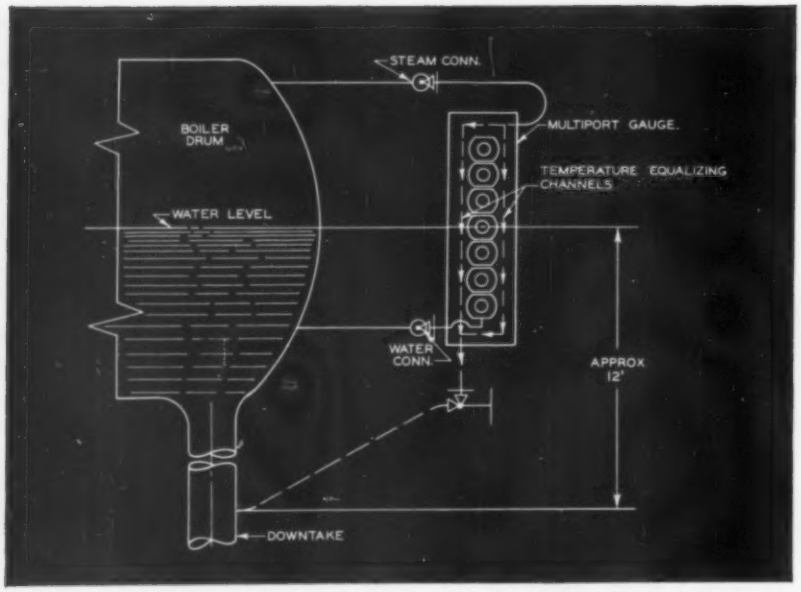


L. J. Wing Mfg. Co.

DIVISION OF AERO SUPPLY MFG. CO. INC.
140 VREELAND MILLS ROAD, LINDEN, NEW JERSEY
FACTORIES: LINDEN, N. J. AND MONTREAL, CANADA

OTHER WING PRODUCTS: Unit Heaters, Fresh Air Supply Heaters, Fans, Turbine and Motor Blowers, Auxiliary Turbines.

ANOTHER NEW GAUGE DEVELOPMENT BY Diamond



Diagramatic illustration of new Diamond Temperature-Equalizing Multi-Port Gauge installation.

The need for correction of inherent gauge error at high operating pressures is well recognized, but heretofore no satisfactory simple answer has been found. Now, Diamond has developed the Temperature-Equalizing Multi-Port Gauge* to reduce the error in gauge level reading by a simple and fully reliable means.

Gauge error (resulting from the gauge temperature being lower than boiler saturation temperature) is substantially avoided by introducing supplementary gauge heating in the form of steam condensing channels. These channels are parallel to the gauge water level channel as illustrated, and serve to heat the gauge level channel by direct conduction of heat from condensing steam through the gauge body itself. No external source of energy or control is required. The heating channels have a natural circulation system independent of the gauge level channel so that no faulty operation can occur under any circumstance.

Ask your local Diamond office or write directly to Lancaster, Ohio for Form 2150 for further information.

*Patent Applied For

8031

DIAMOND POWER SPECIALTY CORP.
LANCASTER, OHIO

DIAMOND SPECIALTY LIMITED—Windsor, Ontario

Cut-away sections illustrate independent gauge body heating channels of the new Diamond Temperature-Equalizing Multi-Port Gauge.

For more data circle 514 on Post Card

HELPFUL BULLETINS

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Cards provided on pages 101 and 102.

FANS AND BLOWERS

101 Extension Shaft Fans — Bulletin 640-A contains application and construction data on extension shaft fans for use wherever fan motor must be kept out of the airstream. A table of ratings as well as dimensional data and diagrams are included. Propellair Div., Robbins & Myers, Inc.

102 Backward-Blade Fan —Details on a backward-blade centrifugal fan designed for heating-ventilating and air conditioning systems, power plant installations and industrial processes are featured in 38-pp Bulletin BB-105. Includes engineering data, specifications, performance tables and selection and arrangement information on 19 basic size centrifugal fans. General Blower Co.

103 Cabinet Blowers — Bulletin CM58 contains details of construction and application suggestions on multi-purpose cabinet blowers. Capacity tables, roughing-in dimensions, size and specification tables are included. Airfan Engineering Co.

PIPING AND VALVES

104 Piping for Corrosives — This pamphlet features Jal-Jacket which combines strength of steel with corrosion resistance of unplasticized PVC pipe. Included are lined drawings, pipe specifications, working pressures, temperatures and installations. Jones & Laughlin Steel Corp.

105 Pipe Connections — This 12-pp bulletin covers company's line of pipe connections, unions, vessel closures and bleeder valves. Methods of construction, specifications and prices, and applications are featured in the bulletin. Photos and diagrams illustrate the text. Gray Tool Co.

106 For Fluid Control — Illustrated Catalog MV-957, 12 pp, on small valves, is devoted to descriptive information and technical data on nine valve series. These include needle valves, panel mounting valves, corrosive service bar stock valves, union bonnet globe valves, toggle valves, metering valves, check valves. Specification tables and flow curves are provided. Also described are micron filters. Hoke, Inc.

107 Flow Regulating Valve — Bulletin 1053 describes and illustrates a flow regulating valve offering two distinct advantages: use of a horizontal rotating lever shaft, and accurate balance in service. Included in bulletin are specifications on sizes, pressures, and materials of construction. Copes-Vulcan Div., Blaw-Knox Co.

108 Air Control Valves — For ease of reference, 108-pp General Catalog 58 is departmentalized into four sections: four-way valves and manifolds; two- and three-way line valves; manual valves and manifolds; pilot and special valves. Each section is preceded by tabbed index page, and book includes application and operational data, specifications, dimensional drawings, parts lists, valve selection charts, valve feature comparison chart, circuit applications table, and data on manifold mounting patterns and vacuum valve applications. Numatics Inc.

109 On Relief Valves — Eight-pp Bulletin 5200-A describes features of multiple disc relief valves for steam systems. Specifications for vertical, horizontal and angle styles in sizes from 4–48 in., 0–25 to 0–100 psig pressure, installation diagrams, data on selecting and specifying included. Cochrane Corp.

110 Safety-Relief Valves — Catalog 118, 44 pp, gives information on selection and sizing of all nozzle safety-relief valves applicable to process piping. Standard and BalanSeal Bellows types of safety-relief valves, as well as data concerning sizing factors and formulae, nozzle capacity, charts, dimension and weight tables included. Farris Engineering Corp.

111 Steel Gate Valves — Engineering features and performance of company's forged steel gate valves are illustrated and described in Circular 607. Cutaway view shows component parts. Lunkenheimer Co.

HOSE AND FITTINGS

112 Flexible Metal Hose — Contained in this 36-pp bulletin is information on characteristics and applications of company's flexible metal hose designed to serve a variety of industrial needs. Includes specifications, list of applications, and photos of the various types of hose available. Typical installations are pictured. Couplings for flexible tubing also covered. Pennsylvania Flexible Metallic Tubing Co., Inc.

113 Hose and Fittings — Rubber covered double wire-braided hose and reusable Hoze-lok fittings are covered in 8-pp Catalog 4430. Included are stainless steel braided hose for non-magnetic service and perforated cover hose for coal shooting. Hose assemblies are cataloged and make-up instructions included. Parker Fittings & Hose Div., Parker-Hannifin Corp.

MECHANICAL POWER TRANSMISSION

114 Adjustable Speed Drive — Bulletin GEA-5827A, 8 pp, describes company's Thymotrol drives — from ¾ to 40 hp — and discusses a wide range of industrial applications for the adjustbale speed drive. Cited are benefits and features as well as modifications available and standard electrical and performance characteristics. Photos, cutaway and line drawings, and charts included. General Electric Co.

115 Electric Power Drives — Catalog 258 contains 64 pp of detailed information on company's line of electric power drives, presented in color coded sections with a simplified numbering system. Catalog contains prices, modifications and dimensions on squirrel cage motors, gear motors, speed reducers, and variable speed drives. Sterling Electric Motors, Inc.

116 Geared Coupling — Folder 2875 details pertinent application and selection data for company's geared flexible couplings designed for use as a motor coupling — for transmitting electric motor power to pumps, generators, speed reducers. Text is illustrated with photos and drawings. Link-Belt Co.

117 Coupling Guide — Twelve-pp Catalog C-210-A features a comprehensive line of couplings, including die cast and steel, fixed bore and bushed, rigid, flexible and chain, as well as unbreakable malleable jaw couplings in both fixed bore and bushed type. Photos, dimensional diagrams and tabulated engineering data included. Browning Mfg. Co.

118 For Coupling Selection — Bulletin 56 describes standard gear couplings, flexible couplings, a new nylon gear coupling requiring no lubrication, couplings for fph motors with direct drives, several other types. Dimensional data provided. John Waldron Corp.

119 Permanent Magnet Pulleys — Bulletin 1021 describes a permanent magnet pulley for tramp iron separation in belt conveyor systems. Performance advantages are detailed and a selection chart is included. Stearns Magnetic Products, Div. Indiana Steel Products Co.

ELECTRICAL

120 Synchronous Generators — Engine-driven, low-speed synchronous generators of up to 450 rpm are described in 8-pp Bulletin GEA-5299B. The bulletin is illustrated with examples of typical services performed by these motors which feature Polyex ground insulation systems and constant-pressure brush holders. General Electric Co.

121 Immersible Motor — Bulletin 2300 describes applications in which submerged motor is close-coupled to pumps, agitators and mixers, eliminating long shaft connections, intermediate bearings, couplings and special bases. Illustrations, specifications and cutaway drawing show engineering features which suit the motor to operation in water, chemicals, abrasive industrial oils and sewage sumps, ratings from ¾ to 40 hp polyphase and ¾ to 5 hp single phase. The Louis Allis Co.

122 Fan Motors — Bulletin GEA-6598, illustrated with photos and dimension table, describes totally enclosed Tri-Clad 55 air-over motors from 7½ to 100 hp for propeller and axial-flow fans. Smaller and lighter than previous models, motors are shown in cut-away view describing various internal improvements. Included are application information, ratings, dimensions. General Electric Co.

123 Distribution Transformers — Features of company's pole-type distribution transformers are described in 24-pp Bulletin GEA-6070C. Reviews design and construction of the transformers, covers testing, packaging and service facilities, and outlines research in a variety of new materials. General Electric Co.

124 Insulated Cable — Properties and characteristics of silicone rubber insulated cables are detailed in 16-pp Form 682–2–58. Discusses individual specifying factors including performance data, service life and physical properties, electrical characteristics, suggested applications, and test results. Charts and photos illustrate comparative service life and performance of organic and silcone rubbers within a temperature range of −55 to 200 C. National Electric Products Corp.

125 Voltage Regulators — Twelve-pp Bulletin S3581E describes a standard line of instantaneous electronic automatic voltage regulators. Gives complete ratings, outline dimensions, features, illustrations and prices on all types in the series. The Superior Electric Co.

126 Oil Circuit Breaker — Integrated construction features providing protection, long life and low maintenance in large outdoor, oil circuit breakers are described in 8-pp Bulletin 71 B 6022D. Photos and drawings illustrate the Pneu-Draulic operator, mechanically trip-free mechanism, and high speed interrupting performance. Dimensional data and diagrams included. Allis-Chalmers Mfg. Co.

127 On Transfer Switches — How to select an automatic transfer switch, and applications of this equipment are covered in 24-pp Publication 596-R1. Discusses in-rush capacity, continuous duty rating, rapid transferral of load, high thermal capacity and ability to withstand electromagnetic effects, double source control, full phase protection, and various structural and operational features. Automatic Switch Co.

128 Molded Case Breakers — Bulletin GEA-6754, 28 pp, provides information needed to select, specify and order molded case circuit breakers and matching enclosures. Includes a simplified guide for determining proper ampere rating of circuit breakers. All products are illustrated, and the text is supplemented by outline dimensional drawings and diagrams. General Electric Co.

129 Underfloor Systems — Catalog 674, 32 pp, discusses underfloor electrical feeder distribution systems for cellular steel floors. Cutaway illustrations show adaptability of company's Headerduct to all types of floor design, while construction views show it in various stages of installation. Suggested procedures for installing duct and fittings are shown, and diagrams provide dimensional data and junction box spacings. Components of system are pictured. National Electric Products Corp.

130 Explosion-Proof Batteries — Bulletin IT-526/58 covers design, use and construction of company's line of explosion-proof Slyver-Clad batteries for all applications. Features and advantages are detailed. C & D Batteries, Inc.

131 Steel Battery Racks — Advantages of mounting stationary-type storage batteries on racks are detailed in this 12-pp Bulletin, Form 4883. Tables, photos, line drawings and typical, step-by-step sample problems simplify selection of racks. Exide Industrial Div., The Electric Storage Battery Co.

132 On Cleaning Motors — Provided in this bulletin on the cleaning of electric motors is information on procedures for cleaning motors and generators; hazards present when using solvents; selection of safe, efficient solvents. Gives data on F.O.-128 and F.O.-101, solvents having low toxicity and high flash point. Fine Organics, Inc.

PUMPS, PUMPING

133 High Pressure Pumps — Bulletin 1070 describes and illustrates typical pumps available for high pressure fluid handling as used in high pressure test loop work, radioactive fluid handling and in other services requiring zero leakage pumping in pressurized systems. Performance and engineering data included. Chempump Corp.

134 Vapor Pumps — Featured in 67-pp Bulletin 6–1 is detailed information on performance characteristics of high vacuum vapor pumps and descriptions of standard models for various high-vacuum requirements. Text is illustrated with photos of typical applications and drawings and diagrams showing operation and design details. Specifications, data tables, dimensional diagrams, pressure curves and temperature and pressure charts supply technical details to make this a valuable working manual. Rochester Div., Consolidated Electrodynamics Corp.

135 Canned Motor Pumps — Features and specifications of company's pumps for general process pumping are detailed in Bulletin 1050–3. Included are performance curves for pumps up to 15 hp, dimensions, principles of construction and operation, cutaway views, materials, power requirements. Chempump Corp.

136 Hydraulic Pumps, Fluid Motors — Catalog 111 describes hydraulic pumps and fluid motors. Gives construction features, performance curves, data on pump-motor combinations, duplex or tandem models and geared flow dividers. Tuthill Pump Co.

MATERIALS HANDLING

137 Diesel Crawler Tractor — Illustrations and text matter in 14-pp Catalog MS-1289 highlight features of company's HD-16 diesel crawler tractor. A gate fold permits a large cutaway view of both gear transmission and torque converter models. Also presented is matched equipment available for this tractor. Specifications are included, as well as two separate "spec" sheets. Allis-Chalmers Mfg. Co.

138 Pneumatic Ash Conveyor — Component features of a pneumatic ash conveyor system are illustrated and described in 12-pp Bulletin 655. A diagrammatic sketch shows a typical example of the system adapted to a powdered fuel plant. Engineering data included. Hydro-Ash Corp.

139 Transportable Elevator — Eight-pp Catalog 852 describes a transportable elevator for maintenance, construction or operational purposes. It takes men and materials up to 250 ft. Cutaway drawings illustrate features and car safety devices, and specifications are included. Hawkeye Products Corp.

BOILERS, HEAT EXCHANGERS

140 Forty Boiler Facts — Twelve-pp Form 1130 covers general characteristics of company's line of boilers, both high and low pressure, firebox and Scotch type. Designed as a non-technical supplement to catalog sheets and descriptive literature on specific models, the bulletin covers 40 facts on boilers, ranging from fabricating details to principles of design and construction. Kewanee Boiler Div., American-Standard.

141 Packaged Boiler — Advantages of company's packaged boiler for capacities from 20 to 200 bhp are detailed in an illustrated 12-pp bulletin. Included are complete data, dimensions and recommended boiler room layouts. Superior Combustion Industries, Inc.

142 Boiler Tube Data — Technical Data Card 157-A lists maximum allowable working pressures, by popular tube sizes, for electric resistance welded boiler tubing. Information is based on latest edition of the ASME Boiler Construction Code and covers tubing for both water tube and fire tube boilers. The Tubular Products Div., The Babcock & Wilcox Co.

143 Preferred Acres — This 8-pp bulletin takes a case study approach in describing an industrial terminal, "Preferred Acres," in which are located a number of diverse industries — all serviced by company's unit steam generators. Cites advantages which prompted these industries to select this equipment. Preferred Utilities Mfg. Corp.

144 Heat Exchanger — Bulletin 302-5K1 describes company's pre-engineered exchanger for handling any combination of liquids and gases, and used as a heater, cooler, condenser or vaporizer. Design and construction details are shown on cutaway diagrams and dimensional data and specifications are included. Ross Heat Exchanger Div., American-Standard.

145 Plate Heat Exchanger — Eight-pp Bulletin A-1067 describes applications, dimensions, specifications and features of the plate heat exchangers, available in floor or wall mounted models. Installation photos are included in the bulletin. The De Laval Separator Co.

146 Heat Exchanger — This 12-pp illustrated bulletin describes the Fin-Pak heat exchanger operable with low-pressure drops under high pressure differentials for gas to gas, gas to air, or gas or air to liquids. Advantages in a variety of fuel burning and process equipment applications are detailed, and flow diagrams, cutaway drawings and schematic diagrams included. The Air Preheater Corp.

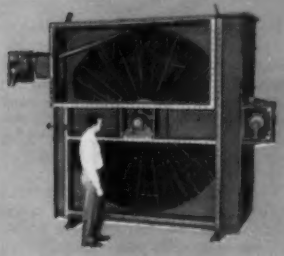
INSTRUMENTS AND CONTROLS

147 Primary Flow Elements — Heart of this 16-pp folder, Bulletin 100-P5-A, is a table comparing company's metering devices in terms of accuracy, range, life expectancy, initial and operating costs, recovery differential, weight, laying length, to tell at a glance which device is best suited for requirements. Cutaway views and cross-sectional drawings included. Builders-Providence, Inc., Div. B-I-F Industries, Inc.

148 Flow Meter Selection — Bulletin 91–119 includes specifications for choosing a flow meter for a given liquid. Advantages and limitations of basic types are given in chart form. Fischer & Porter Co.

149 Bellows Flow Meter — Catalog C22–1, 22 pp, covers features, specifications and applications of company's bellows flow-meter for flow and liquid level measurement. Two basic models — one for open tank liquid level measurement and

Here's what you can do about the high cost of fuel



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A significant amount of your fuel is used to heat the combustion *air* in your boilers. A Package Ljungstrom Air Preheater raises the temperature of combustion air by recovering the heat from the exhaust gas. In preheated air, the fuel you are now using will burn more completely, and much more of it will be *productive* heat.

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THE AIR PREHEATER CORPORATION

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GOODALL *Rubber* EXPANSION JOINTS

LOWER INSTALLATION COSTS...

Goodall Rubber Expansion Joints are easier to install on new construction or as replacements. They are light in weight, with short face-to-face dimensions. Retaining rings or flanges are quickly aligned and bolted. No gaskets are required. The installation takes less time ... at a saving.

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Goodall Rubber Expansion Joints last longer in service because of inherent characteristics of the material from which they are made. There is no *embrittlement* ... continuous movement (flexing) actually keeps the rubber joint "alive". There is no corrosion or electrolysis. Resistance to abrasion is exceptionally high. Replacement costs are lower.

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With Goodall Rubber Expansion Joints only the slightest pressure is required to create movement in any direction. Result—stress on metal pipe or other member is reduced to an absolute minimum. All styles are available in sizes from ⅜" to 96" I.D., for pressures up to 125 lbs. P.S.I. (depending on size) and/or vacuum.

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the other for closed tank liquid level measurement — are featured. Photos, drawings, charts and dimensional diagrams supply illustrative material for the text. Minneapolis-Honeywell Regulator Co.

150 Receiver Recorder — Sixteen-pp Product Specification E12-5 contains details of plug-in components for company's receiver recorder. In all, twelve types of receivers, controllers, retransmitters, and direct measuring devices, from which recorder may be custom-built, are described and specifications given. Bailey Meter Co.

151 Two-Color Gage — Bulletin 2044 describes features and advantages of company's Multi-Port Bi-Color gage for boiler design pressures to 900 psig. Installation methods are illustrated. Diamond Power Specialty Corp.

152 Pyrometers, Supplies — Precision-matched pyrometers and thermocouples which can be used interchangeably with any make of pyrometer or thermocouple thermometer are described in 16-pp Industrial Edition No. 8. Tables of engineering data are included. Also described is company's service for design of special thermocouples and pyrometers. Raymond F. McHugh & Son.

153 Paper Mill Instrumentation — Technical Bulletin 90-130-25 shows how instrumentation of water and waste treating improves efficiency, reduces manpower requirements and saves raw materials in pulp and paper mills. Diagrams included. Fischer & Porter Co.

154 Pneumatic Transmission Lines — Armortube cable, a flexible, armored, multiple-tube transmission line for pneumatic and hydraulic metering and control systems, is described in Specification G91-9. Tables give sizes, shipping weights, tubing and protecting materials, dimensions, and installation data. Bailey Meter Co.

155 Oxygen Analyzer — Bulletin 0-4014 gives comprehensive information on the Model 70 designed for continuous, automatic analysis of dissolved oxygen in high purity water. Information includes applications, specifications, principles of operation, instrument features, as well as mounting dimensions diagram. Beckman Instruments, Inc.

156 Valve Position Transmitter — The pneumatic valve position transmitter, a force-balance device for translating the position of a valve or similar mechanism into a proportioning pneumatic output pressure, is the subject of Bulletin 285-R1. Advantages, operation and application details given. Builders-Providence, Inc., Div. B-I-F Industries, Inc.

157 Pulverizer Control — Bulletin 512 describes company's pulverizer control system as applied to Raymond bowl mill. Diagrammatic drawings illustrates the controlling of primary air flow through pulverizer, coal feed and coal-air temperature. Bailey Meter Co.

158 Type SDS-2 Governor — Bulletin 1046 describes Type SDS-2 governor for steam or motor driven pumps; illustrates suggested hook-ups and mechanical features of the governor, and gives specifications. Governor can be used for excess pressure service in boiler feeding, differential reducing valve service on motor driven pumps, as well as for constant pressure service to 150 psig. Copes-Vulcan Div., Blaw-Knox Co.

• Bituminous coal contributes to plant operating profits by its *productivity* and *stability*. Virtually limitless supply, plus most modern mining methods, gears production to *any volume demand*.

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from ½" to 12" I.D.

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Illustrated are a few of the many types and sizes of Rotojet Tube Cleaners driven by air, steam or water. We analyze each application before recommending equipment that best meets the requirement.

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TOOLS, WELDING

159 On-the-Spot Bending — This 8-pp pocket size booklet outlines bending techniques for Redege Standard and Powr-Jack models of company's portable one-piece bender. Provides shrink table for three-bend pipe saddle installations which gives allowance for shrink of all sizes of conduit when objects being saddled are 1- to 4-in. diam. Also discusses fundamentals of bending electrical metallic tubing etc. National Electric Products Corp.

160 Squirt Welder — Features and applications of a mechanized squirt welder which combines the precision of automatic welding with the flexibility of manual welding are detailed in 6-pp Bulletin 5205.1. Comparative welding speeds and specifications included. The Lincoln Electric Co.

New References On Insulation, Protection

161 Insulation Products — Eight-pp Catalog 12C describes insulation for indoor or outdoor applications for furnaces, boilers, heat exchangers, turbine, piping, others. Covers Thermalite 85% magnesia insulation and Thermasil calcium silicate insulation. Properties, applications, forms, thicknesses and thermal conductivity data are listed. Tables give simplified methods for selecting proper thicknesses for pipe coverings. Procedures for applying and finishing insulation also given. Ehret Magnesia Mfg. Co.

162 Low Temperature Insulation — Vermiculite refrigeration fill, insulating concrete mixes, and asphalt-bound vermiculite for cold storage floor construction are featured in this 8-pp bulletin. Suggestions for proper vapor-barrier treatment are included, as well as specifications. Zonolite Co.

163 Industrial Insulations — Thermal, mechanical, physical, and chemical characteristics of company's industrial insulations are presented in 20-pp Catalog J-424. Includes data on high temperature spun-mineral wool insulating block, blankets, pipe coverings and cements and on mineral wool industrial felts and duct insulation. Thermal conductivities and tables of recommended thicknesses of each material are given for appropriate temperature ranges, and application instructions included. Baldwin-Hill Co.

164 For Insulation Protection — Provided in this comprehensive loose-leaf manual is technical information covering practically every requirement for insulation protection. An aid to proper adaptation and application mastics, flashing compounds, adhesives and surface coatings, this book presents information classified as to industry usage, as power, process, cold storage etc. Material is also classified into product categories. Publication includes general and product data for each category. Book is available to qualified power engineers. Please state your job title when requesting copy. Benjamin Foster Co.

OTHER EQUIPMENT

165 Packaged Cooling Tower — Circular SP-1 contains details on company's Hydra-Glide line of induced-draft, pack-

40-Fan-Cell Double-Flow® Cooling Towers at Clinch River Station

These four 10-cell towers have built-in ability to resist the greatest hazard to cooling tower service — FUNGAL DECAY. The 1,715,000 board feet of lumber used in their construction will set a new standard of durability, for every foot of it was MARLITH pressure protected after fabrication.

It is only logical that the organization that envisioned, engineered and constructed this newest and greatest mine-mouth power facility should recognize this hazard and take steps to prevent its destructive action. By doing so they have assured for the future adequate cold water at efficient operating temperature, and this is just as important to power production as is fuel supply.

This plant is destined to build a new economy for an undeveloped area — a long range project — so its plan includes all the soundly-based advances that modern technology offers for plant longevity. MARLITH treatment has an important role in this program of continued performance for it means that accumulated maintenance costs over the years will be low by any comparison with unprotected cooling towers.

If water conservation is in your development plans (it's good business for you, your neighbor, your nation), you'll find it profitable to get full information from your Marley engineer on MARLITH—the "life insurance" for cooling towers. Ask or write for Marlith Bulletin—M-58.

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Factory-trained Cyclotherm engineers will . . . without charge . . . work with you from drafting board to final installation to estimate your steam demands.
TO SAVE TIME
Factory-trained Cyclotherm servicemen are as close as your telephone . . . at any hour of the day, night or week-ends.
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Cyclotherm Steam Generators range from 15 to 750 hp. . . . from 15 to 200 psi. For industrial and commercial establishments, shipping, institutions.
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STEAM
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GENERATORS

Planning a new building? Remodeling an existing structure? As much as ⅓ smaller than other packaged units, the Cyclotherm Steam or Hot Water Generator allows more space for storage and production. Needs only a minimum-sized, minimum-cost boiler room. Or your Cyclotherm can be placed in a working area. Its radiant heat loss is at a minimum.

Lighter-weight, it costs less to transport. Simpler in design, it requires less rigging time . . . lower rigging costs.

Yet it delivers a guaranteed 80% efficiency . . . pays for itself in a few years in fuel savings alone . . . cuts maintenance costs up to 50%.

Exclusive, patented Cyclonic Combustion combined with simplicity of boiler design produces maximum heat transfer wringing every degree of heat from each fuel molecule . . . wasting none. Does in 2 passes what other combustion methods accomplish in 4. Cyclotherm's even rate of heat transfer eliminates localized, heat-retarding scale and "hot spots." All these features assure you of long life and maximum performance.

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aged water cooling towers for use with commercial and industrial air conditioning systems. Illustrated with photos and line drawings, includes charts giving specifications, dimensions and performance ratings. Mason Products, Inc.

166 Continuous Titration — Data Sheet A-58-2 describes a continuous titrator for use where chemical processes must be controlled by titrating to determine concentrations. Includes a schematic diagram and list of equipment with typical specifications. Milton Roy Co.

167 Jet Cleaning — A system of jet cleaning regenerative air preheaters with water at pressures up to 3000 psi is covered in this illustrated bulletin. Tables of test data are included. Dowell Inc.

168 Coal Crushers — Bulletin 154, 4-pp, includes illustrated descriptions of special construction elements. Cross-section cutaway explains the feeding and crushing action of WC and WS crushers, and tables list capacities, horsepower, speed, dimensions. A survey of users in the field reveals parts replacement costs, and total tonnage costs. American Pulverizer Co.

169 Service Capabilities — This 16-pp illustrated booklet presents research, engineering, development and production capabilities of a manufacturer of precision instruments . . . oscillographs, galvanometers, dynamometers, special purpose devices. Covers design departments, laboratories, assembly areas, others. Hathaway Instrument Div., Hamilton Watch Co.

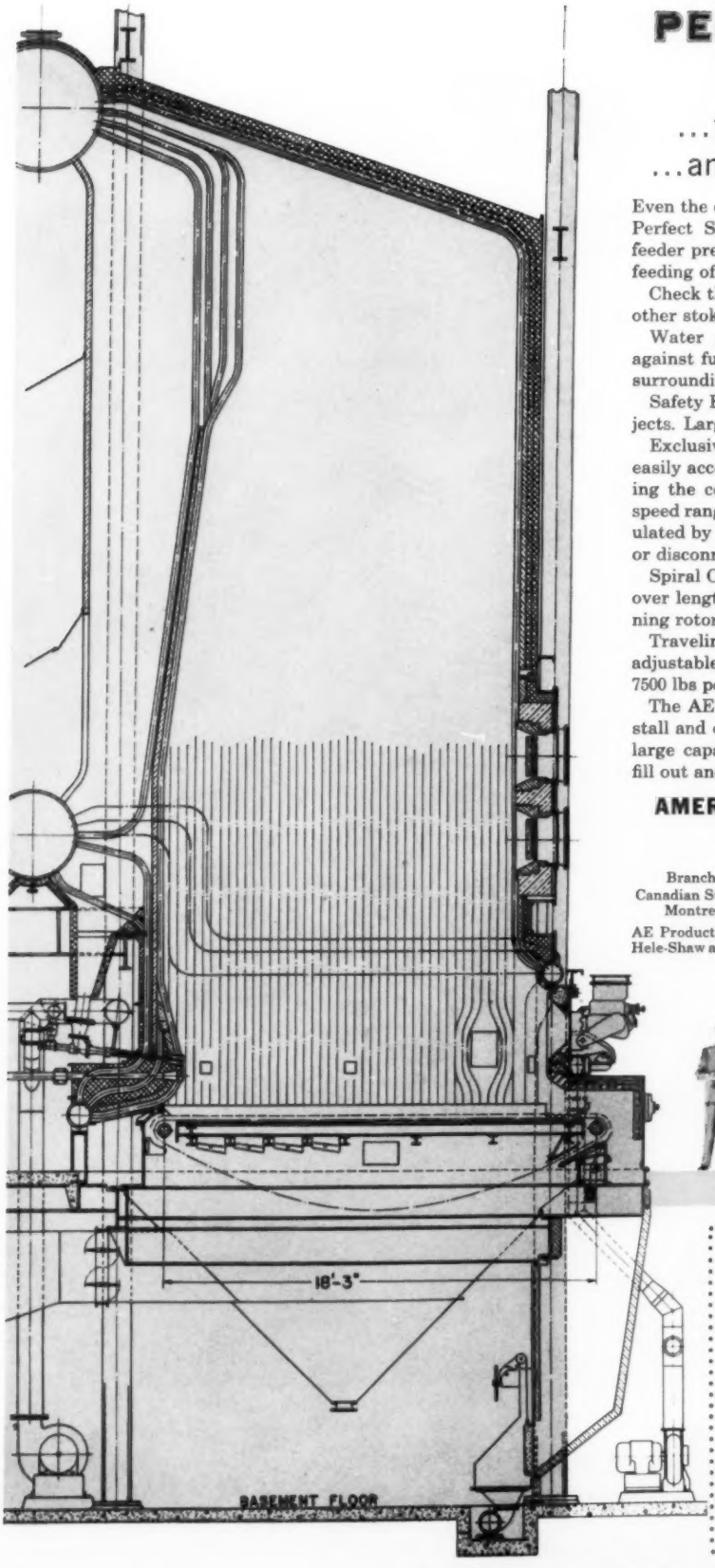
170 For Better Fuel Performance — Two products related to use of fuel are discussed in this bulletin: a sludge dispersant for fuel oil, and a soot remover. Explains basic causes of formation of fuel oil sludge and of soot in combustion areas, and principles involved in removal and elimination. Western Chemical Co.

171 For Water Treating — This illustrated 8-pp instruction booklet describes water treatment for evaporative condensers, cooling tower systems, ice-making machines and chilled water systems. Covers scale remover, economy powdered acid, Banox, algaecide, Instantreet, others. Features Micromet Plates, a slowly soluble self-feeding phosphate that prevents scale and corrosion. Calgon Co.

172 Air Systems — Bulletin S-4, 8 pp, describes ovens, dryers and heaters used to produce the "engineered atmospheres" required for paper drying and conditioning, pulp and paper mill ventilating heating and cooling, paint finishing, hot blast cupola operation, and other processes requiring engineered air systems. J. O. Ross Engineering Corp., Div. Midland-Ross Corp.

173 Incandescent Lighting — The 24-pp "Incandescent Lighting Guide Book" features sections on general advantages of incandescent lighting, and history of incandescent lamp developments. Includes chapters on basic types, bulb shapes, sizes, glass types and finishes, types of bases, and performance characteristics. Sylvania Electric Products Inc.

174 Static Magnetic Annunciator — Bulletin 101 contains information on a static-magnetic annunciator developed for monitoring complex automatic machine and continuous process operations. Includes section on typical logic functions of control elements, also features a typical logic diagram. Panellit, Inc.



PERFECT SPREAD STOKER

...for large capacity boilers ...and large capacity efficiency

Even the cheapest and wettest coal burns evenly in the Perfect Spread Stoker. Exclusive design automatic feeder prevents clogging, guarantees positive uniform feeding of the finest grades of coal.

Check these AE Perfect Spread features against any other stoker:

Water and Air Cooling—Entire feeder protected against furnace temperatures by water and air cooling surrounding furnace opening and rotor bearings.

Safety Features—Prevent damage from foreign objects. Large objects stop feeder or rotor without harm.

Exclusive Traveling Conveyor Feeder—All-enclosed, easily accessible mechanism operates in oil bath, driving the conveyor feeder through a widely adjustable speed range smoothly and quietly. Feeder units are regulated by automatic combustion control, can be shut off or disconnected independently of other feeders.

Spiral Overthrow Rotor—Perfect spread distribution over length and breadth of stoker by continuous spinning rotor of exclusive design.

Traveling Grate—Engineered reinjection system—adjustable overfire air nozzles—coal feed from 50 to 7500 lbs per hour.

The AE Perfect Spread Stoker costs less to buy, install and operate. You get large capacity burning and large capacity efficiency. To get full technical details fill out and mail the coupon.

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Branch Offices in: Jersey City · Cleveland · Chicago
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AE Products are: Taylor, Perfect Spread and Vibra-Grate Stokers, Hele-Shaw and Hydramite Fluid Power, Lo-Hed® Hoists, Lo-Hed Car Pullers, Marine Deck Auxiliaries

AMERICAN ENGINEERING COMPANY
Wheatsheaf Lane & Sepviva St., Philadelphia 37, Penna. S-101

Gentlemen: Please send me full information on low cost steam with the

- ☐ AE Perfect Spread Stoker
- ☐ AE Taylor Underfeed Stoker
- ☐ AE Vibra-Grate Stoker

NAME_____ TITLE_____

COMPANY_____

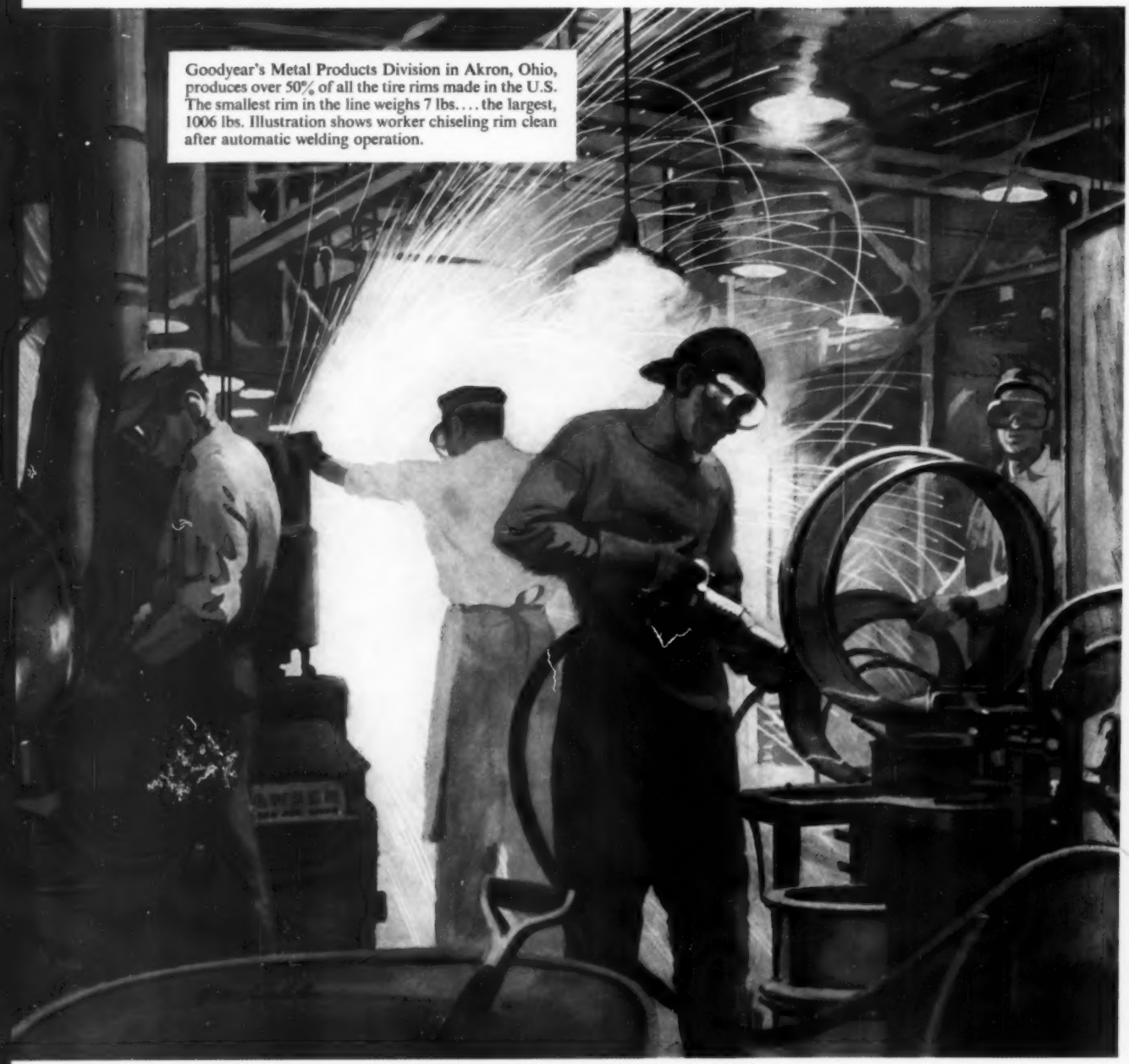
STREET_____

CITY_____ ZONE_____ STATE_____

For more data circle 521 on Post Card

Correct Lubrication in Action...

Hydraulic Pump Life



Goodyear's Metal Products Division in Akron, Ohio, produces over 50% of all the tire rims made in the U.S. The smallest rim in the line weighs 7 lbs.... the largest, 1006 lbs. Illustration shows worker chiseling rim clean after automatic welding operation.

Mobil

Complete Engineering Program
Proved Petroleum Products

Mobil

SOCONY MOBIL OIL CO., INC., and Affiliates: MAGNOLIA PETROLEUM CO., GENERAL PETROLEUM CORP., MOBIL OVERSEAS OIL CO., INC.

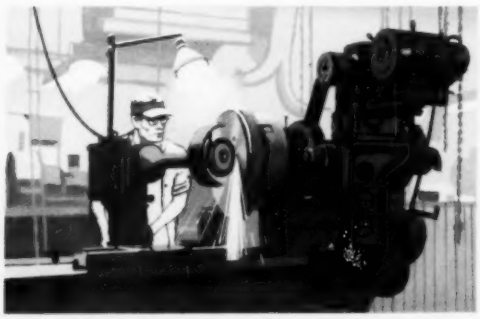
Increased as much as 221%

One of the ways Socony Mobil helped The Goodyear Tire and Rubber Company save over twice the cost of lubricants purchased in 1957

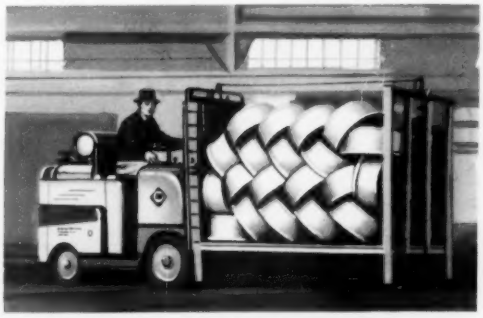
Nearly 100 pumps actuate the hydraulic presses and other equipment used to produce wheel rims at Goodyear's Metal Products Division. Under a Mobil program of Correct Lubrication some of these pumps have been in continuous service twice their expected life. Others with a normal plant service life of five years are still operating after *11 years*. This plant has never had a pump failure due to lubrication since the Mobil program began.

The fact that a pump failure, besides halting production, can cost up to $400 for labor and $3300 for other repairs underscores this record.

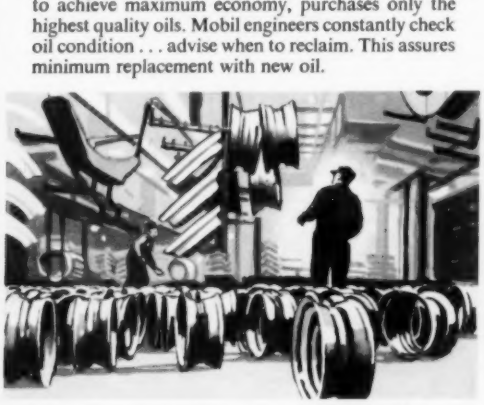
Here is another example of Correct Lubrication in Action. This cost-cutting Mobil Program gives you the benefit of complete engineering service throughout your plant . . . plus the benefits of Mobil's laboratory facilities . . . and 92 years of lubrication experience. It is turning maintenance costs into profits for The Goodyear Tire and Rubber Company. Why not for you?



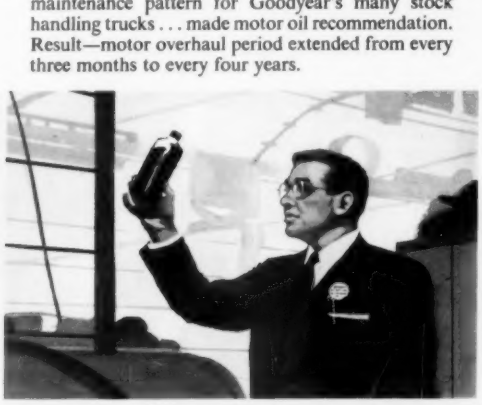
$21,400 saved. Under the Mobil Program, Goodyear, to achieve maximum economy, purchases only the highest quality oils. Mobil engineers constantly check oil condition . . . advise when to reclaim. This assures minimum replacement with new oil.



$825 a year saved. Mobil engineers helped set up maintenance pattern for Goodyear's many stock handling trucks . . . made motor oil recommendation. Result—motor overhaul period extended from every three months to every four years.



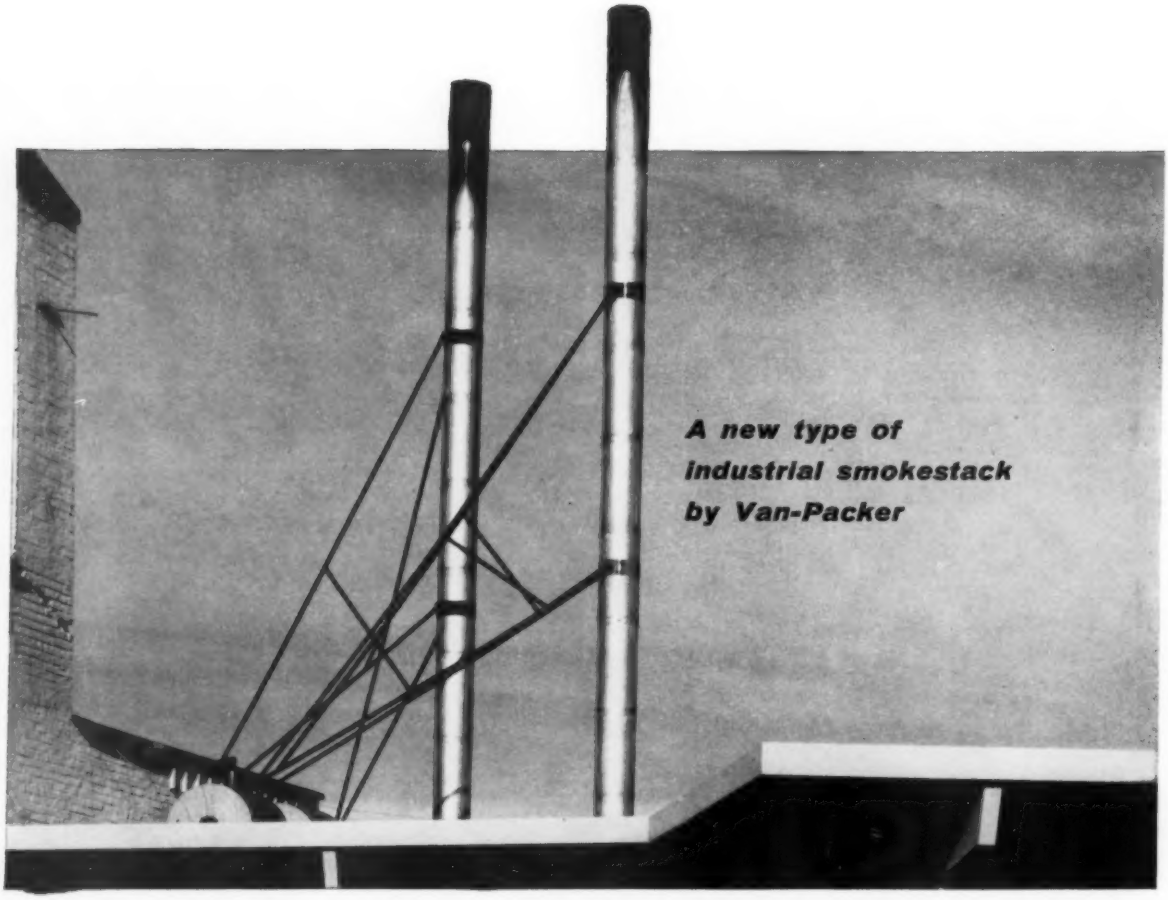
$6,000 a year saved. High temperatures in paint drying ovens caused stoppage of conveyor system . . . cost $500 a month in labor and materials. Mobil recommendation of special grease eliminated breakdowns.



Total 1957 savings—2.7 times purchase price of oils and greases. Through close cooperation between company personnel and Mobil engineers, maintenance costs are held to a minimum...oils deliver maximum life.

Correct Lubrication

Another reason <u>You're Miles Ahead with Mobil!</u>



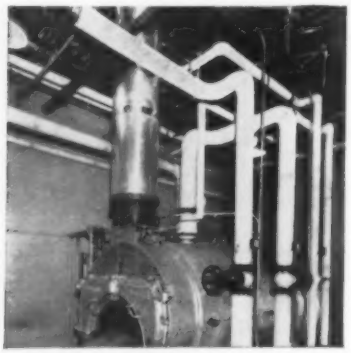
Get longer stack life at lower cost

Permanent construction — Because the Van-Packer is made of non-corroding refractory material it will outlast a steel stack as much as three times. The aluminum jacket which encases each stack section eliminates maintenance.

Low Cost — The Van-Packer costs no more than a steel stack, and only 1/3 as much as brick. Other savings result from fast installation, savings on maintenance, and long life. Handles all fuels for boilers, furnaces, incinerators.

Prefabricated refractory sections—Centrifugally-cast 3-foot sections combine the economy of a steel stack with the permanence and high draft of a brick stack. Seven diameters from 10-inch ID to 30-inch ID.

Available nationwide — Van-Packer Stack is available through local Van-Packer Jobbers and Special Representatives. See "Chimneys — Prefabricated" in Yellow Pages, or write Van-Packer for Bulletin IS-32-59.



Van-Packer Stack with Standard Sections handles boilers and furnaces efficiently. Can be superimposed or floor supported.

Installing this stack is quick and easy. Three-foot sections are simply cemented atop one another with acid-proof cement.

Van-Packer Hi-Temp Stack handles incinerators with flue gas temperatures up to 2000° F. without corroding.

Van-Packer PREFABRICATED REFRACTORY **Stack**

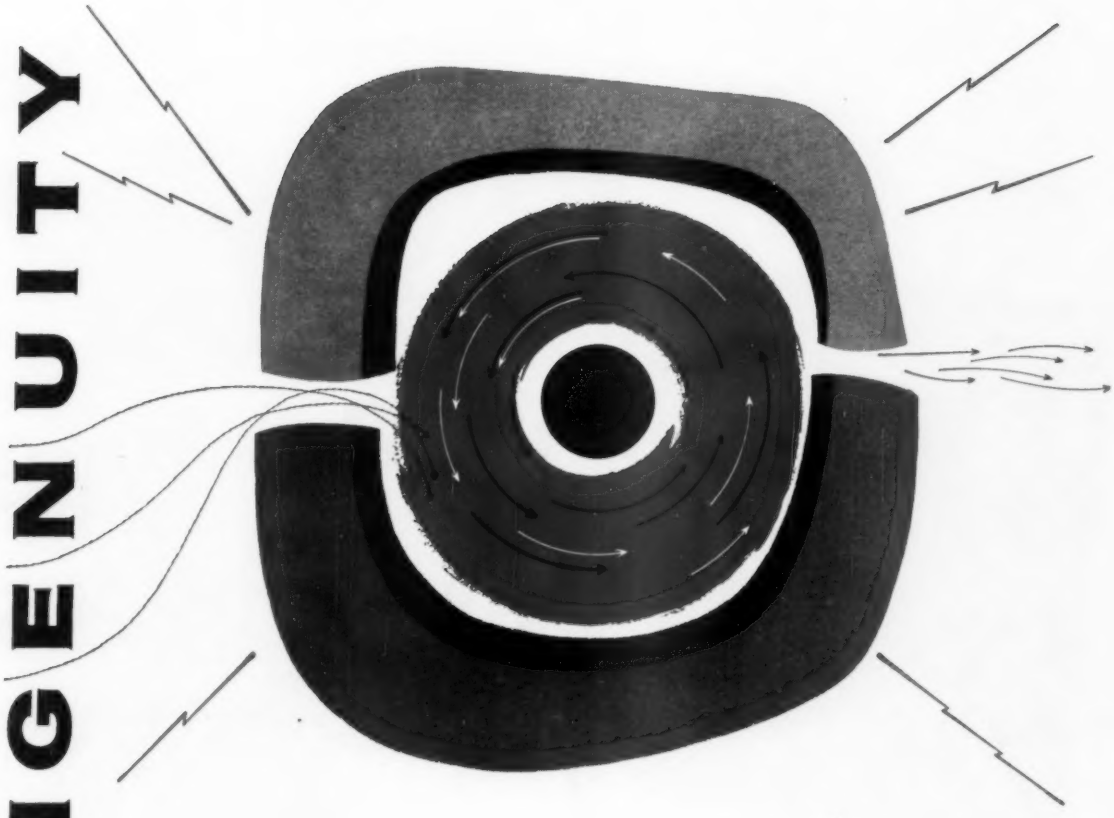
Van-Packer Company • Division of the Flintkote Company
P. O. Box No. 306, Bettendorf, Iowa • Phone East Moline, Ill. 3-5286

Sweet's

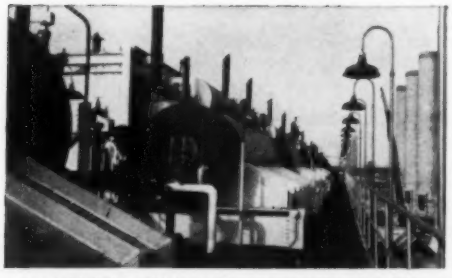
For more data circle 523 on Post Card

call KE for plant expansion or new facilities

INGENUITY



has made KE a major builder of power facilities



A 475,000 KW power generating facility, engineered and built by KE.

Faster construction, more efficient operation, lower costs—these are benefits Kaiser Engineers' ingenuity has brought to power projects ranging from America's largest dam to power installations for industrial plants.

Experienced KE engineers can take your power idea from a gleam in your eye through start-up—from economic analysis through operator training.

Whether your future power needs are thermal or nuclear, call KE. Let KE's ingenuity produce real time and money savings for you.

KAISER ENGINEERS engineers—contractors
Contracting since 1914

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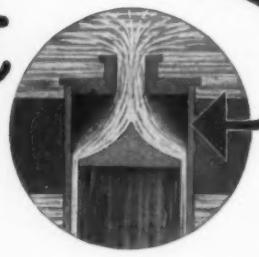
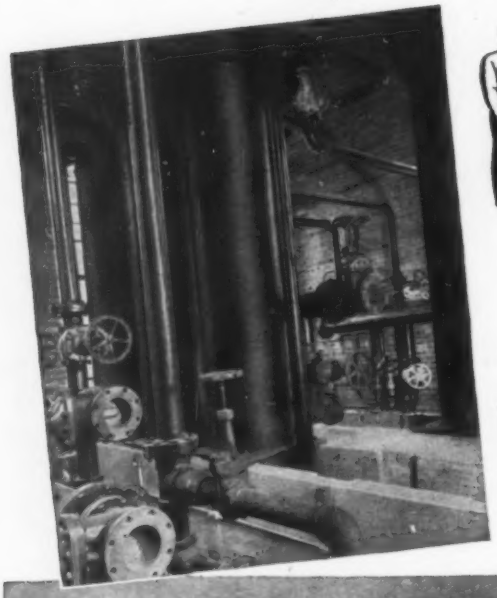
Dirty Water can't "Shut-down"...

Vogt

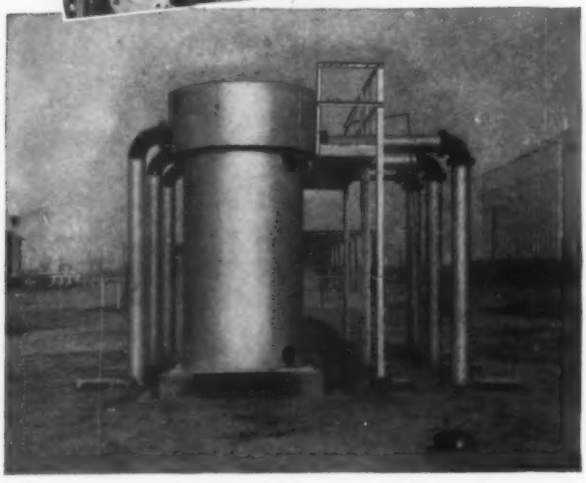




film type exchangers

(Condensers—Coolers—Evaporators)

Patent Nos. 1,935,270 - 2,057,597 - 2,424,441



River water, well water or brackish water are all alike to this exchanger *because it can be cleaned* while in operation! The water distributing ferrules need only be removed successively for the cleaning brush or tool whereby the tubes receive additional water which sluices away the dislodged dirt.

Vogt Film Type Exchangers are operating with real economy of first cost, operation and maintenance in power, petroleum, and chemical industries. They serve as Jacket Water Coolers, Feed Water Heaters, Hydrocarbon Evaporators, Sulphuric Acid Coolers, and Sulphur Dioxide Condensers, and can be designed to cool or heat any liquid and to condense or evaporate any fluid.

TOP: *Four units at Newton Falls, Ohio Municipal plant cool water for diesel engines and a lubricating oil cooler.*

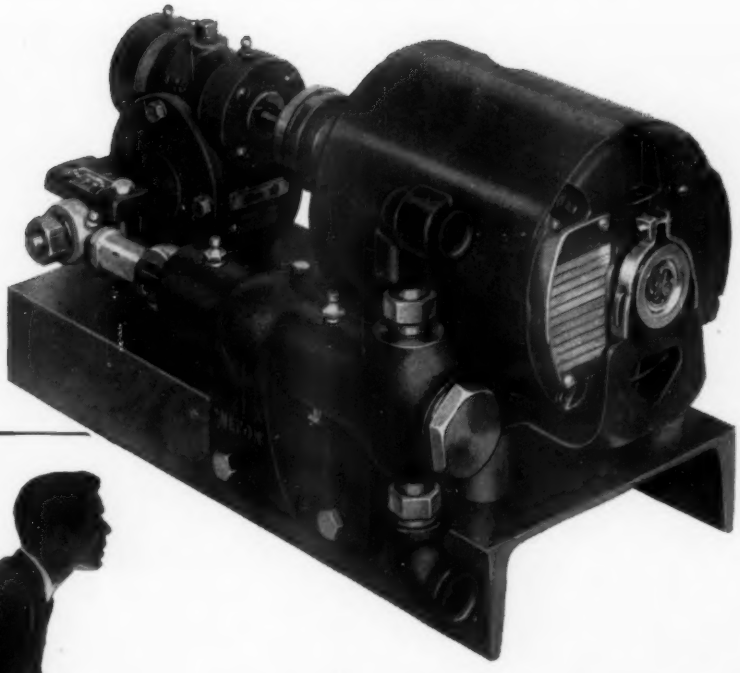
BOTTOM: *Jacket Water Coolers serving engines of 7,300 HP in the compression plant of a Western Oil Refinery.*

[Bulletin HE-7 describes typical installations of Vogt Film Type exchangers and is available upon request. Dept. 24A-XPE]

HENRY VOGT MACHINE CO., LOUISVILLE, KY.

Sales Offices: NEW YORK, CHICAGO, CLEVELAND, DALLAS, PHILADELPHIA, CINCINNATI, ST. LOUIS, CHARLESTON, W. VA.

For more data circle 525 on Post Card



Look again

At the Milton Roy H20® Controlled Volume Pump

Here's low-cost protection for your boilers . . . Milton Roy H20 controlled volume pumps have capacities ranging from 0.12 to 56 gph, for pressures up to 1100 psi. Both simplex and duplex models are available—for immediate delivery from stock—with stainless steel or cast iron liquid ends.

H20 pumps will give you accurate metering—efficiently and economically—of boiler-water treatment chemicals and other mildly corrosive and non-corrosive liquids. Depend on these pumps for long service life with a minimum of maintenance. And Milton Roy H20 pumps are available in complete packaged systems for boiler feed-water treatment . . . consisting of a steel tank, H20 pump, relief valve and suction piping.

Take a second look at these quality pumps . . . and always look to Milton Roy for assistance in the solution of your most difficult controlled volume pumping problems. Write for detailed information—Bulletin 557—Milton Roy Company, 1300 East Mermaid Lane, Philadelphia 18, Pa. Engineering representatives throughout the world.

Controlled Volume Pumps • Quantichem Analyzers
Chemical Feed Systems • Anders Air and Gas Dryers

milton Roy
CHEMICAL INSTRUMENTATION SYSTEMS

For more data circle 526 on Post Card

Bailey Controls for Combustion, Feed Water and Steam Temperature at the St. Clair Power Plant of Detroit Edison Company. The FPC reported a 1956 heat rate at St. Clair of 9,200 Btu per kwhr, making it the sixth most efficient plant in the United States.

Why Bailey is the choice of America's most efficient* STEAM PLANTS!

Take the top six on the Federal Power Commission's heat rate report. All use Bailey Meters and Controls. Five of the six chose Bailey *exclusively!*

Coincidence? Let's take a *larger* sample. Out of the top 46 "most efficient" power plants listed, 38 use Bailey products. Here's why:

1. A Complete Line of Equipment

You can be sure a Bailey Engineer will offer the right combination of equipment to fit your needs. Bailey manufactures a complete line of standard, compatible pneumatic and electric metering and control equipment that has proved itself. Thousands of successful installations involving problems in measurement, combustion, and automatic control are your assurance of the best possible system.

2. Experience

Bailey Engineers have been making steam plants work efficiently for more than forty years. Veteran engineer and new engineer alike, the men who represent Bailey, are storehouses of knowledge on measurement and control. They are up-to-the-minute on the latest developments that can be applied to your problem.

3. Sales and Service Convenient to You

There's a Bailey District Office or Resident Engineer close to you. Check your phone book for expert engineering counsel on your steam plant control problems.

***6 MOST EFFICIENT PLANTS—1956 Heat Rates Reported by FPC**

	Btu/kwhr	Meters	Combustion Control	Feed Water Control	Supht. Control
1. Tanners Creek (Indiana and Michigan Electric Company)	9,106	B	B	B	B
2. Kanawha River (Appalachian Electric Power Company)	9,115	B	B	B	B
3. Kyger Creek (The Ohio Power Company)	9,176	B		B	B
4. Muskingum River (The Ohio Power Company)	9,176	B	B	B	B
5. Clifty Creek (Indiana-Kentucky Electric Company)	9,200	B	B	B	B
6. St. Clair (The Detroit Edison Company)	9,200	B	B	B	B

A140-1

Instruments and controls for power and process

BAILEY METER COMPANY

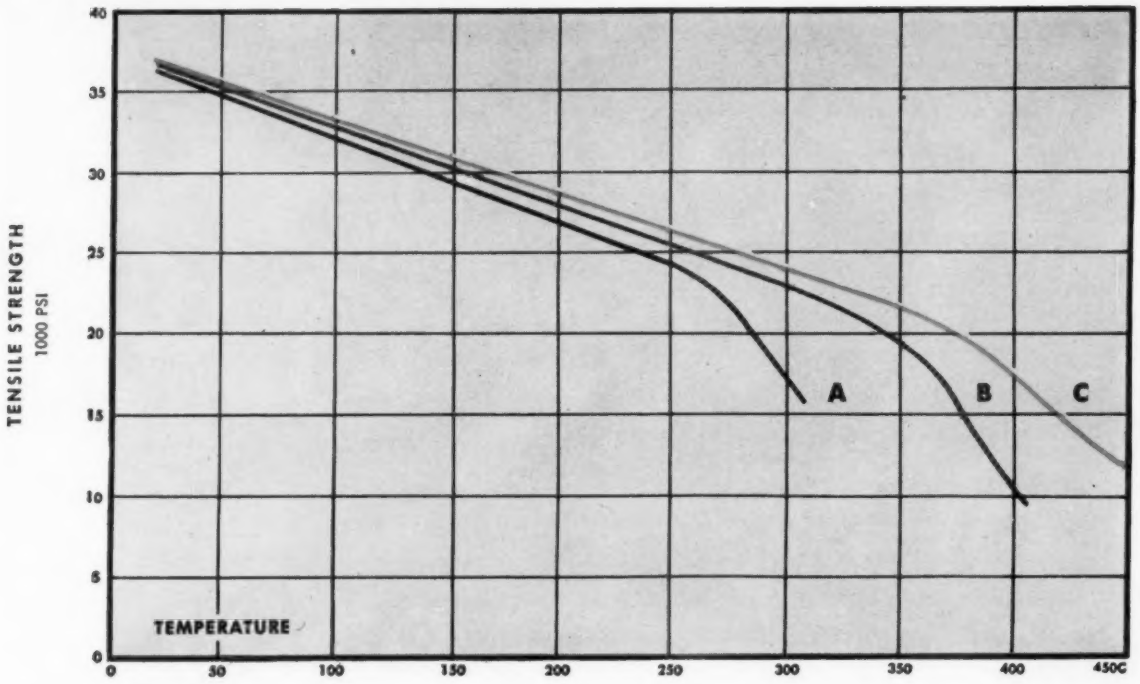
1040 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

BAILEY METERS

For more data circle 527 on Post Card

How silver helps copper conductors at elevated temperatures



THE INFLUENCE of silver on the tensile properties of high-conductivity copper at elevated temperatures. Tests made by the Metallurgical Research Laboratory of The American Brass Company. The test pieces were copper strips, cold-rolled to a temper approximately that of hard-drawn rectangular bus bar.
A. Electrolytic copper, silver content normal
B. Electrolytic copper, silver 8.7 ounces per ton added
C. Electrolytic copper, silver 28 ounces per ton added

In heavily loaded motors and generators, the windings, collector rings, and commutators must retain their strength at the higher operating temperatures that have become the rule. And there are now many other places where copper conductors must operate at temperatures well above those heretofore considered normal.

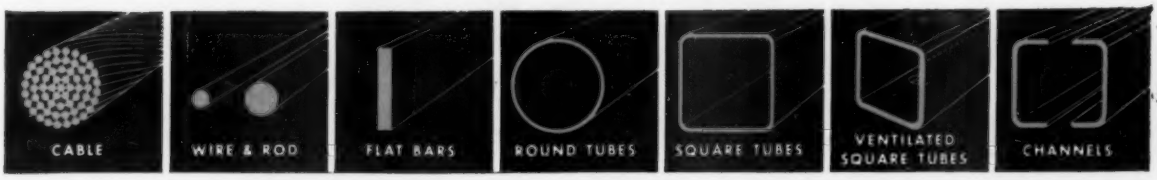
Electrolytic copper—with a very small amount of silver added—is superior to any other commercial conductor metal for use at these higher temperatures. Anaconda silver-bearing copper retains the structural design strength of the conductor at the higher operating temperatures. Annealing temperature is raised and softening delayed. The margin of safety is improved. How much gain you can count on is indicated by the chart above.

More complete information is available in the Sixth Edition of The American Brass Company's Publication C-25, "Anaconda Copper for Electrical Conductors." In addition, this 62-page booklet has convenient new tables giving physical and electrical data on all types of rigid bus conductors for the most commonly used sizes—plus a wealth of general information on the properties of copper conductors.

TECHNICAL SERVICE. The assistance of Anaconda specialists in the selection of conductors to meet your special problems is available to you. For such assistance — or to get a copy of "Anaconda Copper for Electrical Conductors" — see your nearby Anaconda representative. Or write: The American Brass Company, Waterbury 20, Conn. 58100 Rev.

ANACONDA® COPPER CONDUCTORS

THERE'S AN ANACONDA ELECTRICAL CONDUCTOR FOR EVERY NEED



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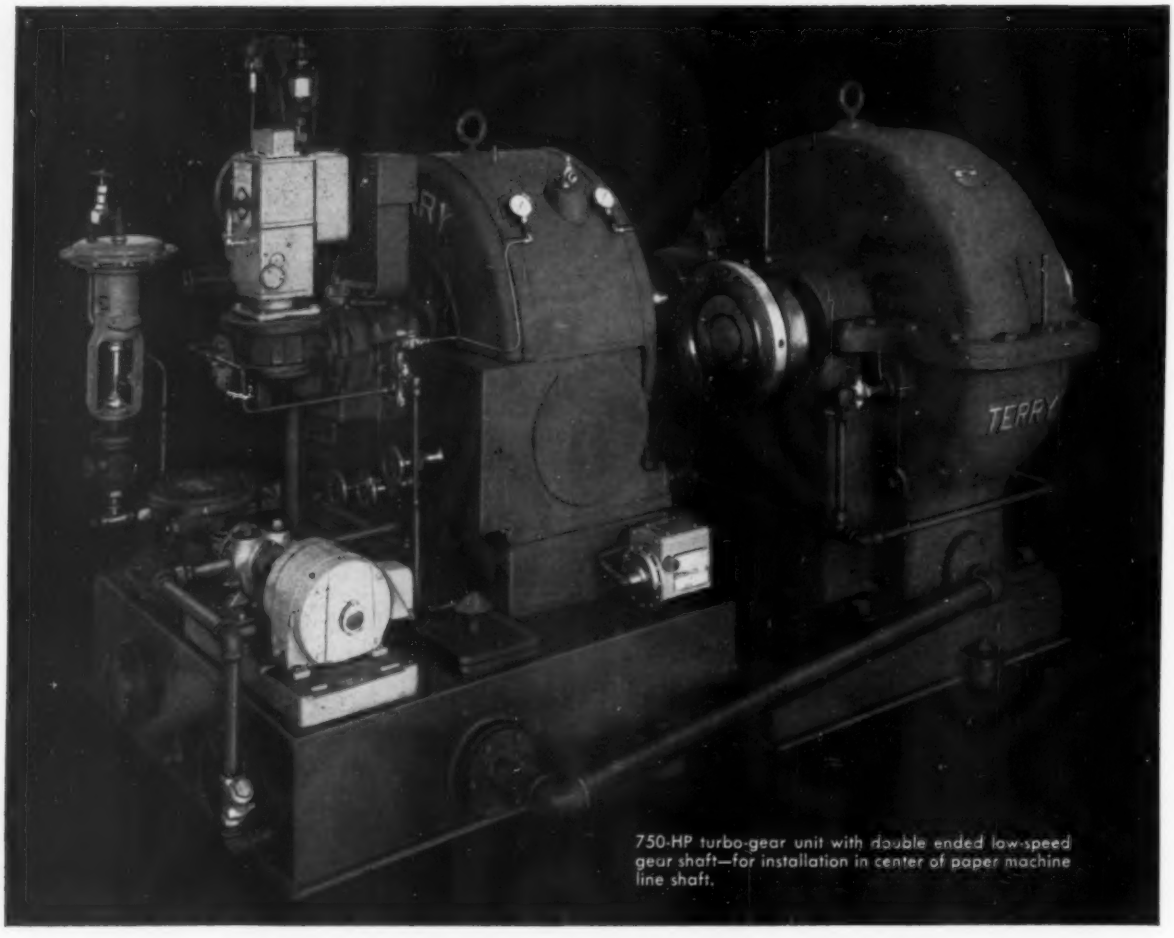


750-HP turbo-gear unit with double ended low-speed gear shaft—for installation in center of paper machine line shaft.

LOW-SPEED TURBINE DRIVES

tailored to meet your requirements

For more than half a century, Terry has been one of the principal suppliers of turbo-gear units for driving slow-speed fans, generators, paper machines, large pumps and the like. Each unit is designed to meet the job requirements. The paper-machine drive illustrated is a good example of this *individualized engineering*.

In service at a large southeastern paper mill, the unit delivers 750 HP at 3350/500 RPM, with steam conditions of 450 lbs., 660°F and 50 lbs. back pressure. Equipped with a variable-speed governor, operated by remote control, the speed of the unit may be varied through a 10:1 range. Other features include forced-feed lubrication to turbine and gear bearings, and automatic shutdown and alarm in case of low oil pressure.

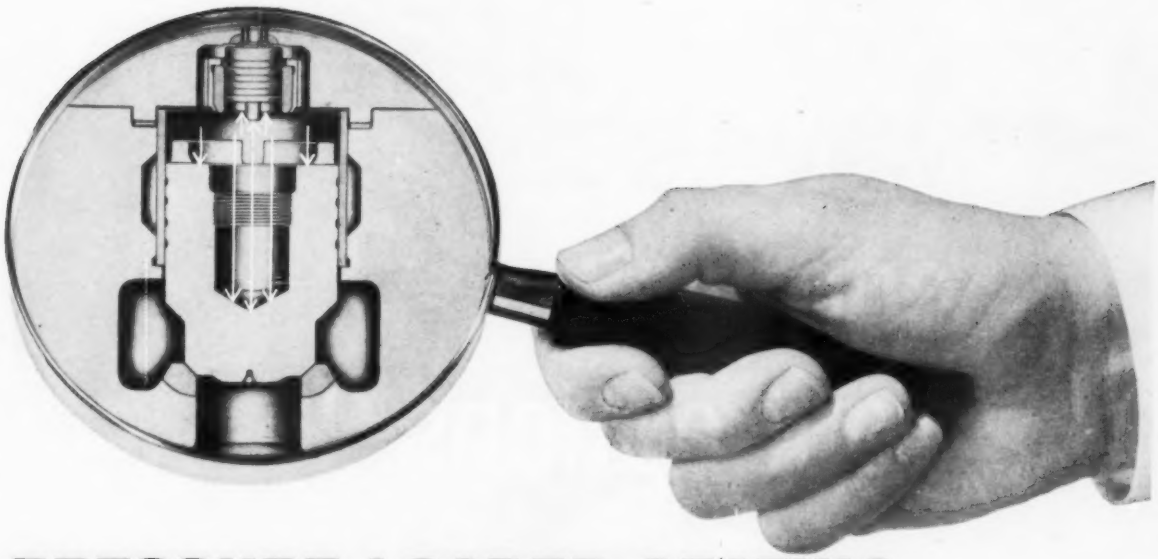
Whatever *your* requirements for low-speed turbine drives, a Terry engineer will be pleased to discuss them with you. Bulletin S-140 covers the full line of Terry turbines; Terry gears are described in bulletin S-130.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TERRY

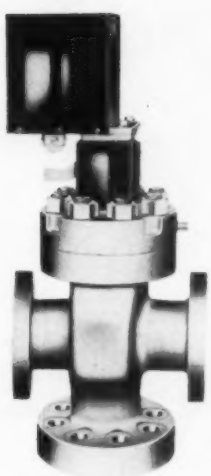
TT-1212

For more data circle 329 on Post Card



PRESSURE LOADED SEATING

minimizes leakage and maintenance



Consolidated Electromatic Relief Valve. Sizes: 2½" to 14". Pressures to 3000 psi. Temperatures to 1120°F. Double Outlet.

Consolidated Electromatic® Relief Valves save steam, pure water, fuel, and "wear and tear" on your spring-loaded valves. Pressure loaded seating permits closer adjustment between operating pressure and set point than in spring-loaded valves. Many Electromatics are used to purge superheaters for faster startups and as superheater vent valves. They greatly reduce chances of superheater damage when firing up a cold steam generator or banked boiler.

Pressure loaded seating is created by channeling steam from the pressure vessel around the Electromatic's exhaust and into its main and pilot valve chambers. Steam pressure in both chambers always matches that in the vessel when the Electromatic is closed.

When pressure exceeds the Electromatic's set point, a signal from controller to panelboard control station results in solenoid thrust that opens the pilot valve, venting the steam faster than it can enter the pilot valve chamber through the clearance between the main valve disc and guide. With pressure in the chambers unbalanced, the main valve opens; steam exhausts until boiler pressure is reduced to the pre-determined setting of the controller. The pilot valve and the main valve close instantly at this point. Action is so fast, the closely adjusted Consolidated Electromatic normally relieves overpressure before the spring-loaded valve's set point is reached. For automatic or manual operation or to cut the valve out of service, a switch is provided on the control station. Send for Bulletin 720.

MANNING MAXWELL & MOORE INC. TRADE MARK

CONSOLIDATED SAFETY VALVES

A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Stratford, Connecticut
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

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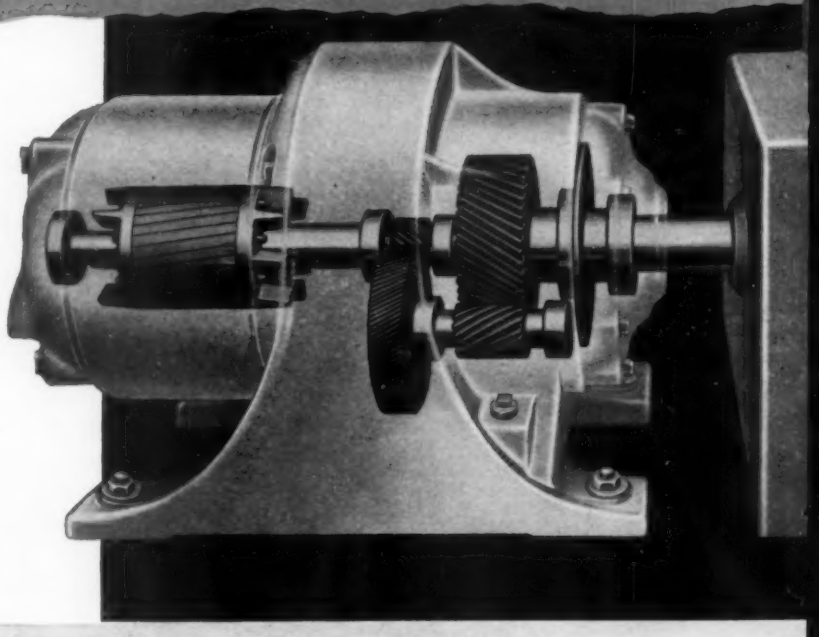
simplify...

with this self-contained geared power package...

U.S. Syncrogear motor!



Don't trust your production to cumbersome contraptions that slip... misalign... and create operator safety hazards. Instead of buying a "unit" that requires belts, pulleys, separate motor, and turnbuckle or rails to be added at extra expense... instead of spending costly production time on recurring adjustments—take the easy, simple, economical way to geared power with U.S. Syncrogear Motors. Syncrogear Motors can't slip! Can't misalign! Can't endanger operator! They give you *positive* power delivery in one compact, self-contained package—steady slow shaft-speeds, permanent precise alignment, maximum efficiency and long life. Best of all, U.S. MOTOR dependability! Available in RATINGS ⅓ TO 30 H.P.

U.S. ELECTRICAL MOTORS INC.

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SEND FOR FREE 16-PAGE BROCHURE... illustrated in full color... on U.S. Syncrogear motors.

Power Engineering

ATOMICS

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BARRINGTON, ILLINOIS

A POWER ENGINEERING FEATURE FOR UTILITY & MAJOR INDUSTRIAL EXECUTIVES

A. W. Kramer, Editor

A Periodic Report on Atomic Energy Development Throughout the World
Published by Technical Publishing Co.

July 1, 1958

Top Secret? There are many strange and mysterious phenomena in this business of atomic energy but none are more baffling perhaps than the gradual emergence of top secret data into the light of day. Just why some particular aspect of peacetime atomic energy development should be a heavily guarded secret one day and then suddenly be disclosed to the world the next is somewhat difficult for the average person to understand; indeed, even smart nuclear scientists are puzzled by this curious phenomena.

Three years ago, at the last Atoms-For-Peace Conference at Geneva, the subject of thermonuclear power was not on the agenda. This subject at that time was under heavy wraps -- something not to be talked about, despite the fact that almost everyone remotely concerned with the nuclear field knew that work was being done on fusion. The idea of a controlled thermonuclear reaction had prevailed for a number of years and it would have been stupid for us not to have engaged in this field of research in view of the great rewards inherent in its success. Officially, however, the Atomic Energy Commission released no information. The specific reason for secrecy advanced by Chairman Strauss was that a thermonuclear reactor would be a source of neutrons and therefore a potential source of special material -- meaning, of course, plutonium. Plutonium can be used in atomic bombs.

Then, suddenly, in his presidential address at the opening of the 1955 Geneva conference, Dr. Homi J. Bhabha brought the subject into the open. He indicated his belief that such a reaction might be developed and cited the work that theoretical scientists in India were doing towards finding an answer to the problem.

As a result of this first frank and open discussion, the representatives of both the United States and Great Britain admitted that both countries had thermonuclear research programs under way but no details were forthcoming. It was not until Dr. Kirchatov, the Russian nuclear scientist, delivered his famous address on thermonuclear development at the British Atomic Energy Research establishment at Harwell, in March of 1956, that the cards were really thrown on the table. In an amazingly frank and remarkably informative lecture, Kurchatov described what the Soviet scientists had done in this field; and what they had done was impressive. As Jerome Luntz, the Editor of Nucleonics, said in his report of that lecture, "We think it is unfortunate that the initiative in this field was left to the USSR."

Again, the AEC disclosed a little more information as to what was going on in this country. A picture of the Perhapsatron was released and we began to hear of the Sherwood Project, and Project Matterhorn, under which our thermonuclear work was being carried on.

Finally, last year, in August and September, rumors became prevalent that Great Britain was making great progress in the thermonuclear field, and once again, under the threat that a foreign group might "steal the show", the AEC, with rather obvious reluctance, made arrangements with the British to release information on the respective thermonuclear programs in January of this year.

So, little by little, step by step, always as a result of action by some foreign country, we have released information on the fusion research that has been going on in this country for several years. Today, we openly speak of the Stellerator being built at Princeton University. Evidently the fact that a thermonuclear reactor may be a source of special material is no longer a valid reason for secrecy.

Geneva 1958. For these reasons, it should be obvious that the subject of controlled thermonuclear research will be very much on the agenda at the second U.N. Geneva Conference on Peaceful Uses of Atomic Energy in September. All nations engaged in this field of endeavor are expected to present papers on the subject and for the first time major efforts are expected to be devoted by the big three (U. S., England, and Russia) to exhibits on fusion. This will be the first time that such devices will have been shown to the public.

Our own contribution this time will no doubt be impressive, since our exhibits will be housed in a special building being built on the grounds of the Palais of the United Nations.

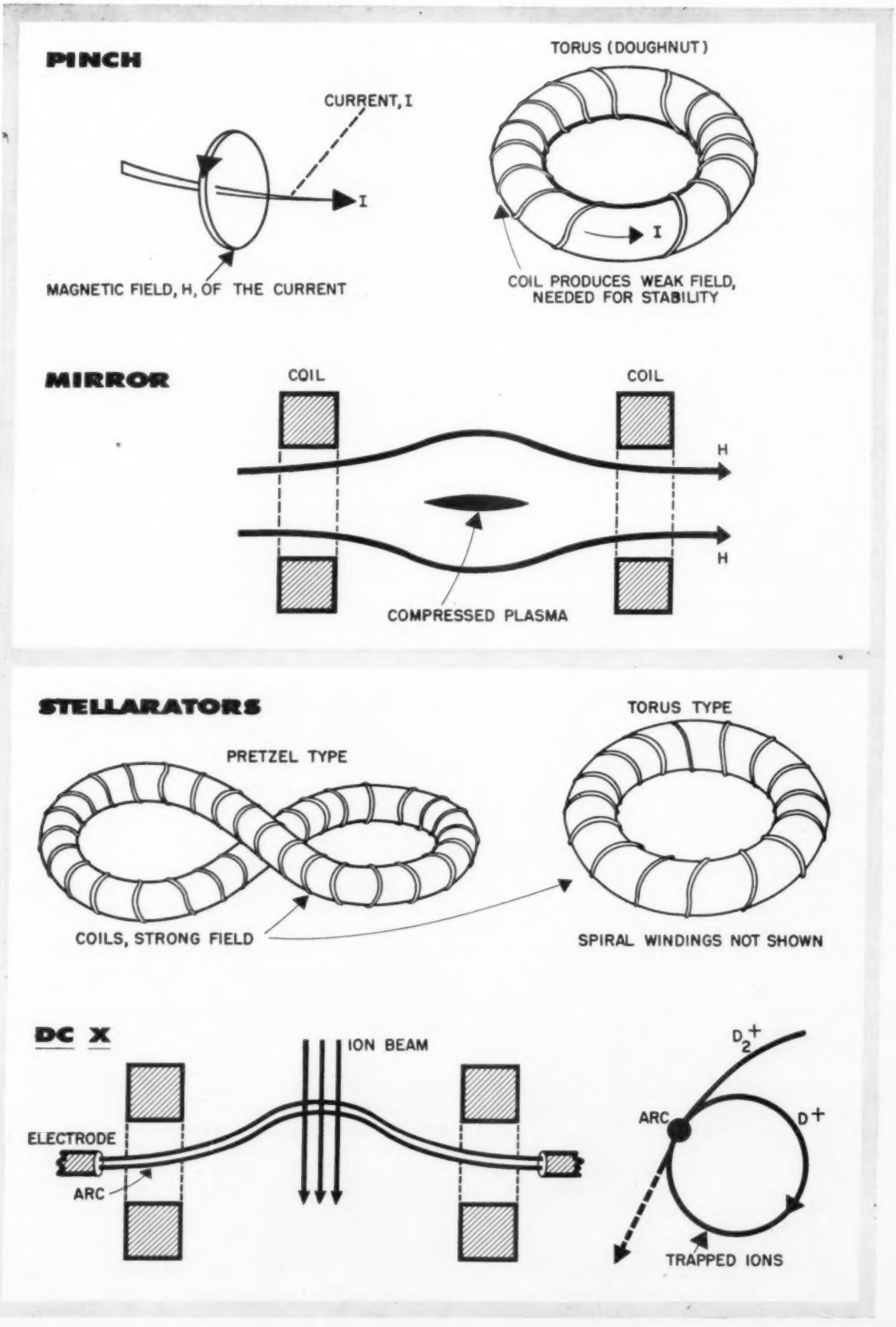
Three Goals. All the laboratories engaged in the thermonuclear program are preparing detailed papers at the Conference. Work in this field is being carried on at Livermore, Princeton, Oak Ridge, and at Los Alamos.

While the approach in each of the laboratories is different, all of the experimental work in the Sherwood program is concerned with very dilute and very hot gas, confined by strong magnetic fields. Such a gas is called a plasma. The program can be thought of in terms of three successive goals: First, to bring the plasma to the so-called ignition temperature; second, to obtain a thermonuclear reaction yielding net power; and, three, to make an economic power producer.

While the term ignition temperature is used it is really not correct to apply the word temperature to plasmas produced in laboratories. One trouble is that the plasma is not a simple gas. It is made up of electrons and positive ions and the average energy of the two types of charges can be quite different. The term temperature should be regarded as a measure of the energy of the ions, which are nuclei of heavy hydrogen. These very hot plasmas send out radiation copiously. This tends to cool them, and the nuclear reaction must be vigorous enough to keep the plasma hot in spite of the radiation loss. The ignition temperature is the degree of heat at which the nuclear reactions in the hot gas give out as much power as the gas emits in the form of radiation. There is a general belief in the American laboratories that the ignition temperature will be achieved within a few years.

A machine operating at the ignition temperature might not be a net power producer. The power producer has to take care of all heat losses, and supply energy for all equipment necessary to make the reactor run. So far, there is no real proof that a thermonuclear reactor producing net power can be built, nor that the plasma will be stable at the relatively high density and temperature which are required. At present the main job is to reach the ignition temperature. Experience leads to the belief that several successive generations of machines of increasing complexity and power will have to be built before we approach a net power producer.

Four Routes To Fusion. The business of igniting the plasma can be approached in a number of ways. One can think of many hybrid methods but four methods show par-


PINCH
CURRENT, I
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STELLARATORS
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TORUS TYPE
COILS, STRONG FIELD
SPIRAL WINDINGS NOT SHOWN
DC X
ION BEAM
ELECTRODE
ARC
D_2^+
ARC
D^+
TRAPPED IONS

ticular promise. The drawings on these pages show the general nature of these four processes.

1. In the pinch method used at Los Alamos, Berkeley, and Livermore, tremendous currents are passed through the gas. The magnetic force of the current tends to constrict or "pinch" the plasma towards the center line of the tube. In other words, the plasma pinches itself with great increase in density and temperature. Straight tubes are often used in studying the phenomena but the main effort involves the use of doughnut shaped tubes. This sounds simple but it isn't. The thin filament of high density plasma tends to be unstable and many refinements are necessary to provide stability and long confinement. This method was discussed at length by Drs. Tuck, Colgate and Spitzer and by the British last January.

2. In Dr. Post's mirror program energetic ions (with accompanying electrons) are injected into a strong field provided by two large coils. At first the ions run on spirals nearly at right angles to the field. Then the current in the big coils is increased. This squeezes the hot gas. In different designs it is possible to squeeze the gas radially and to push it together along the axis. It is also possible to push the gas from one chamber to another.

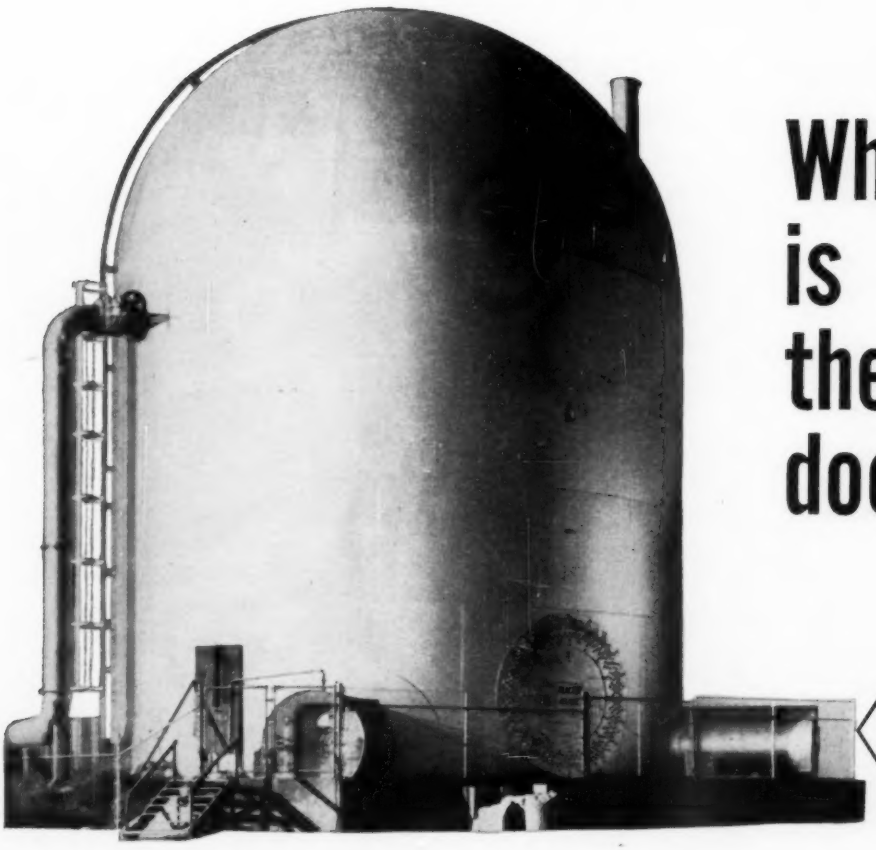
3. In the Princeton Stellarators, they start with a cold gas, confined by a very strong magnetic field. A small current is passed, and then a larger one is caused to flow by transformer action. This brings the gas to something more than a million degrees Centigrade. At that point this heating method is no longer satisfactory because the electrical resistance of the gas has become too low. (A well-ionized gas may have an electrical resistance far less than a solid bar of copper occupying the same space.) Therefore, the next step is to shake the gas with very strong alternating magnetic fields. This heating process is called magnetic pumping. Dr. Spitzer showed that under these conditions the gas would drift toward the walls, and that this loss of gas could be largely avoided by bending the doughnut into a shape like a pretzel. Later, it was found that good gas confinement could be achieved in a doughnut, by ingenious tailoring of the magnetic field. Both methods have been under study at Princeton.

4. The work reported from Oak Ridge is devoted to filling a confinement-space with super-hot ions; that is, ions which have an energy far superior to the ignition energy. It rests on the idea that an extremely hot plasma of low density has good confinement properties, and can be used to heat cooler ions which are added after the very hot plasma is formed. Loss of hot ions by trading of charges with the residual gas molecules in the vessel is a chief enemy in this method; it is also minimized when the ion-energy is very high.

Then John Luce showed how molecular ions can be trapped inside the confinement space. Molecular ions are introduced and are dissociated. Each molecular ion breaks up into an atomic ion (a deuteron) and an atom of deuterium. The atoms escape, but the hot ions are caught on smaller orbits and circulate in the confining magnetic field. The whole matter hinges on efficient dissociation of the molecular ions. It is not enough to let them encounter molecules of the residual gas. Luce supplied an essential step when he developed a high-vacuum, high-current arc in which the high energy molecular ions can be broken up with considerable efficiency. So far work on this method has been done with continuous injection into mirror coils with direct current. Hence the apparatus is called the DC Experiment or DCX.

Plans. For the present it is planned to proceed with all of the four lines of work outlined here. Of course, there is always the question of stability of very hot plasmas which may eventually single out one method, or a few methods in preference to others. If any one of them should falter, there are modifications, hybrid methods, and several basic ideas to be called into play. The Model C Stellarator complex of equipment at Princeton is expected to be in operation in 1960. It provides larger and more powerful devices for the Princeton group. Similarly the other groups introduce larger power sources and new models of their devices. The work is being advanced very rapidly and there is general optimism in all four laboratories about further advances in the period just ahead.

A. W. Kramer



Where is the door?

These two tubular entrances are the Pratt Air Locks in the Vallecitos Boiling Water Reactor at the General Electric Vallecitos Atomic Laboratory at Pleasanton, California.

The Henry Pratt Personnel Air Lock

provides easy passage in and out of containment vessels in full compliance with the AEC code for reactor construction.

While the Air Locks are designed and built specifically for each atomic power plant, they all include some very desirable Pratt developments.

An interlocking feature that keeps one door shut while the other is open is typical of the many simple operating principles that add up to a high safety factor. Any arrangements of automatic and manual controls can be incorporated.

The locks can be built to withstand any practical pressure with compression or pneumatic door seals . . . size is no problem—locks are now being built that will accommodate trucks.

Air Locks already installed . . . Two locks in the Boiling Water Reactor of General Electric's Vallecitos Atomic Laboratory, Pleasanton, California . . . Two locks in the M.I.T. Research Reactor.

Air Locks now being built. . . Three locks for the C.N.R.N. Reactor, Ispra, Italy . . . One lock for the Enrico Fermi Atomic Power Plant of the Detroit Edison Co., Laguna Beach, Michigan . . . Two locks for the 30 MW Test Reactor at the General Electric Vallecitos Atomic Laboratory, Pleasanton, California.

Manufacturers of

Personnel Air Locks
Rubber Seat Butterfly Valves
Turbine-Condenser Expansion Joints
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Specialized Steel Fabrication

HENRY PRATT

One of the two Pratt Air Locks now in use at the M.I.T. Research Reactor.

Henry Pratt Company, 2222 S. Halsted St., Chicago 8, Ill. Representatives in principal cities

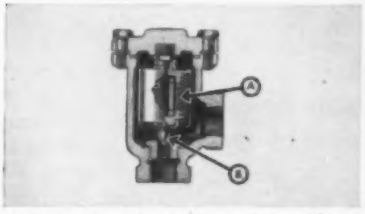
For more data circle 532 on Post Card

Full-range steam traps cut high cost of steam pressure variations

By John W. Ritter, Test Engineer
SARCO Company, Inc.

While boiler room economics dictate that boiler pressures remain constant, the equally sound economics of batch processing may decree that pressures at the equipment vary with the requirement of the process. The attempt to choose a steam trap that is all things to all conditions may result in installing traps that operate inefficiently at either extreme of their pressure range or that require adjustment every time the operations sheet calls for another pressure-temperature setting. Orifice traps represent a somewhat more rational approach to the problem, but often at the price of a continuous discharge of steam, particularly at the low pressures of start-up and shut down. Compromise, adjustment, and steam waste all spell inefficiency in the utilization of steam.

Production-Planned steam trapping, on the other hand, improves efficiency by the use of properly designed and installed thermostatic steam traps. Such traps employ the expansion and contraction of a thermostatic element to operate the discharge valve.



In Sarco Thermostatic Steam Trap, element (A) expands at steam temperature to close valve (B), contracts to permit discharge of condensate.

In the Sarco "Balanced Pressure" Thermostatic Steam Trap a volatile fluid is sealed inside a metal bellows that opens or closes the valve as it contracts or expands with condensate temperature. Near steam temperature, evaporation of the fluid creates an internal pressure greater than steam pressure in the trap body, and the expanding bellows seats the valve. When the condensate cools, the element contracts and opens the valve.

It is evident that at steam temperature pressure inside the element is higher than steam pressure, no matter how the latter may vary. Thus, the trap compensates automatically for variations in pressure.

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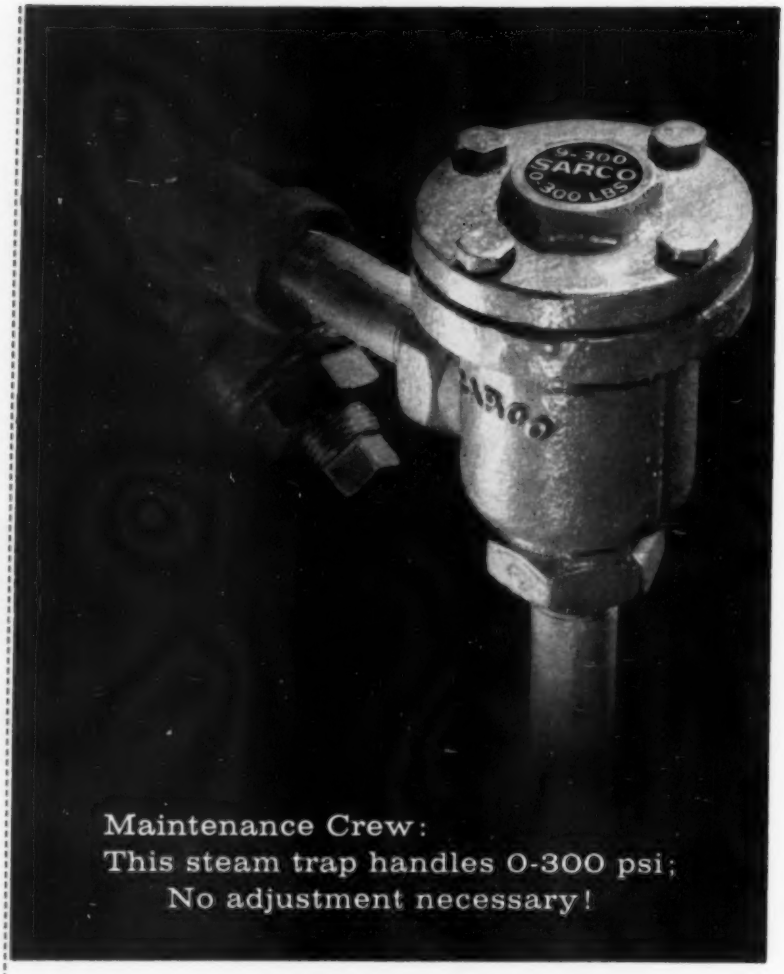

Sarco "Balanced Pressure" Thermostatic Steam Traps cut trap maintenance costs and simplify parts inventory. Why? Because the same bellows, head and seat handle steam pressures up to 300 psi – without any need of adjustment for variations in load or pressure.

Other advantages: unmatched capacity/cost ratio (1" size discharges 9,650 lbs/hr. at 10°F below steam temperature, 125 psi). This trap can't air-bind and, when installed with free discharge, can't freeze.

Long life and reliable performance are assured by an exclusive Sarco process for fabricating the one moving part – the thermostat – and by steam-testing of every single trap at maximum rated pressure.

Write for "Literature Kit 1A" today. And remember, Sarco can give you impartial advice on *Production-Planned* steam trapping because . . .

SARCO
COMPANY, INC.
635 Madison Ave., New York 22, N. Y.

Only Sarco makes all 5 types:
Thermostatic • Liquid Expansion • Float Thermostatic
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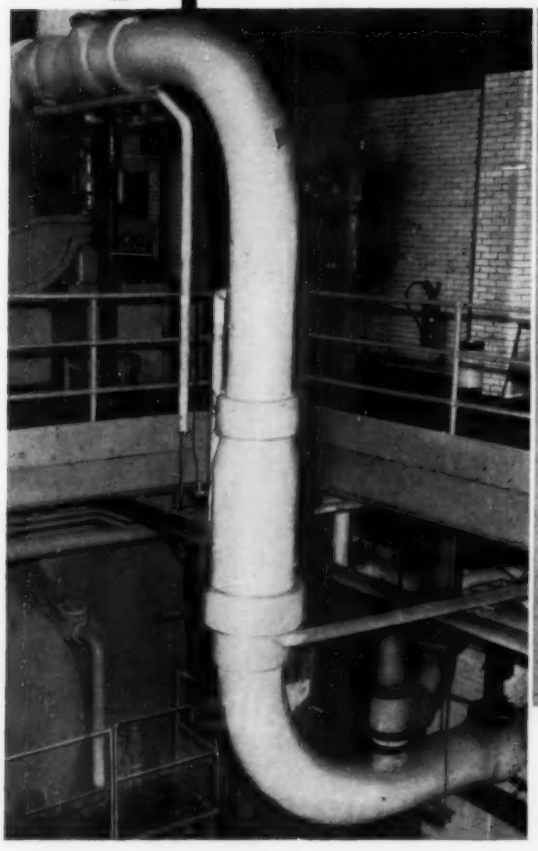
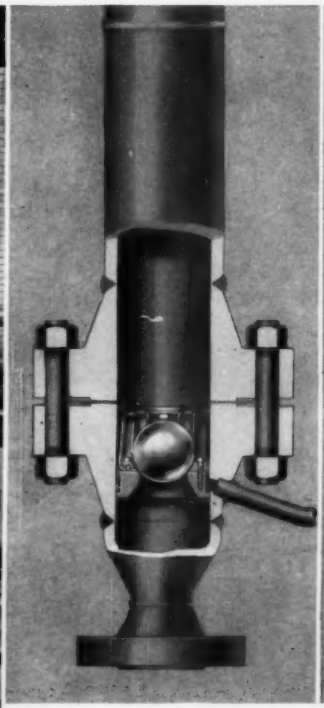
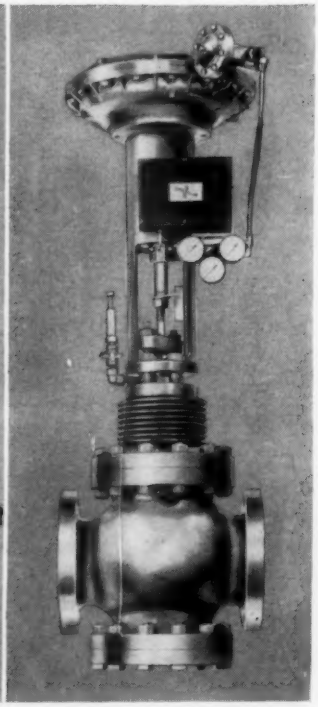
COPES VULCAN | BLAW-KNOX

How Copes-Vulcan control systems boost power plant efficiency





Steel ball controls orifice opening. Incoming steam lifts the ball in an amount determined by the weight of the ball and the amount of steam flow. Pressure drop of about 3 psig is held constant at all rates of flow.



Copes-Vulcan valve . . . for regulating desuperheater cooling water. Noted for accuracy and dependability, Type CV-D diaphragm-operated valve is available in sizes to 12-inch. Write for Bulletin 1027.

New Copes-Vulcan Desuperheater handles the tough temperature control jobs

Using a unique design principle Copes-Vulcan's newly developed Variable-Orifice Desuperheater* provides superior temperature control demanded on the most critical job. Installed in a steam header supplying a 12,500-kw turbine-generator, this desuperheater holds temperatures within a plus-or-minus 3F limit—even though it is located just 20 feet upstream of the turbine throttle.

With only one outside connection and only one moving part, the Variable-Orifice Desuperheater simplifies maintenance. Skillful design eliminates the need for long runs of piping, atomizing steam, spray nozzle and glands.

The Variable-Orifice Desuperheater is one of several types—each engineered to meet particular operating requirements. Write for Bulletin 1037.

Single source . . . custom design . . . skilled service

Desuperheaters are a part of Copes-Vulcan's complete line of control systems for superheat and reheat temperatures, feed water, combustion and pressure reducing operations.

Available in separate units or integrated into a single package, these control systems are custom-designed to meet individual specifications, and are serviced periodically by experienced Copes-Vulcan field engineers. For a survey of the line, write for Bulletin 1022-B.

*Patent applied for.

Copes-Vulcan Division
BLAW-KNOX COMPANY
Erie 4, Pennsylvania

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YARWAY impulse®

Yarway Impulse* Traps are the only steam traps that continually test for condensate in the line ahead of the trap and operate to discharge it as soon as it forms.

You gain by higher temperatures, steadier temperatures, peak operation of steam heated equipment at all times.

* . . . A COMPLETE LINE OF STEAM TRAPS, ALL OPERATING ON A PROVEN THERMODYNAMIC PRINCIPLE.

Manufactured by YARNALL-WARING CO., 100 Mermaid Avenue, Philadelphia 18, Pa.
Stocked and sold by 270 Industrial Distributors
Write for free bulletin "The Why and How of Steam Trapping."

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TRACERS

Power Engineering's Monthly Probe of Power Facts

An electric motor has been developed in Britain that combines the simplicity and reliability of the squirrel-cage alternating current motor with the possibility of infinite speed control of the direct current motor. Idea is to vary the angle between the stationary field and the direction of rotation of the motor. Metropolitan-Vickers has produced a 1-hp, 300 to 900-rpm prototype, is now building one of about 200 hp.

How about using rocket fuels for gas turbines? Researchers C. C. Miesse and P. Lieberman (page 69 of this issue) show that the rocket motor turbine can become an industrial reality. The system is simple. Its effective utilization depends only on man's ingenuity.

Last winter, the coal industry sold about 1.6 tons of coal per residential electric heating customer, in a test group of all-electric homes. Costs ran from $180 to $240 annually for a house of 1200 sq ft. If the electric heating idea spreads to 50,000,000 homes, it would mean the electric utilities will be a potential market for an additional 375,000,000 tons of coal a year.

Four methods of achieving ignition of the plasma (gas) of a thermonuclear reaction show particular promise at this time. For a description of these approaches to the fascinating world of fusion power, turn to the ATOMICS newsletter, page 45 of this issue.

A house that doesn't have to be heated at all, so to speak, but gets all its heat requirements from the sun, is the large Solar House recently opened to the public near Phoenix, Arizona, by the Association for Applied Solar Energy. This house's solar system, designed by John I. Yellott, is expected to pay for itself in less than ten years. Cost of its heating-cooling is figured at $450 a year, including maintenance.

Wire for the electrical industry — two newsworthy developments: 1. A process for producing aluminum-covered steel wire that has the strength of steel along with high conductivity and corrosion resistance. 2. A high-temperature magnet wire which extends the useful range of glass-covered wire from 180 C to temperatures ranging from 220 C to uses in 500 C systems. No. 1 is from Copperweld Steel Co via research at Battelle Memorial Institute. No. 2 is from Anaconda Wire & Cable Co.

Fouling of tubes has always been a problem with condensers. Today, backwash systems of steam surface condensers, out of the developmental stage, will eliminate down-time, reduce manpower to a minimum, and restore generating potential. How backwashing works is described in the article by Hitzeman and Feist, page 72 of this issue.

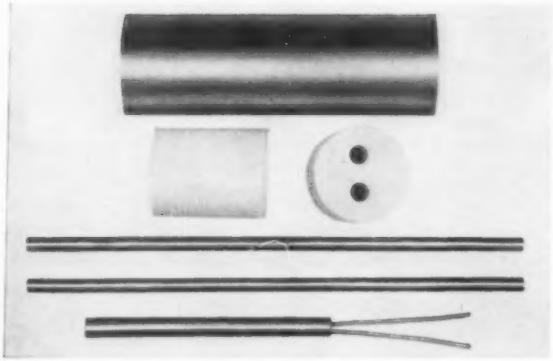

Fig. 1. Component parts and finished MI cable. Shown are copper sheath, insulator, conductors and complete cable

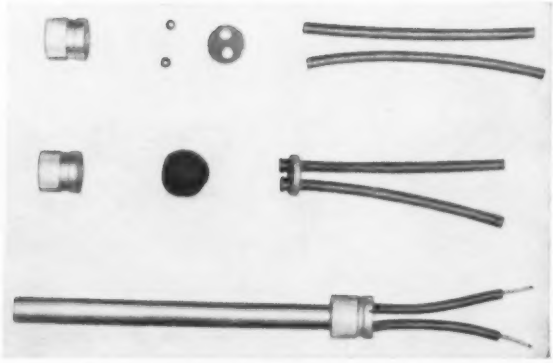

Fig. 2. Cable Seal Termination, showing insulating cap, spacer, Neoprene tubing, compound, and complete terminal

Eliminate Wiring Problems With Mineral-Insulated Cable

Versatile electric cable, with mineral insulation and copper sheath, solves many power wiring problems. Copper and magnesium oxide are only materials used in product which serves as a complete system

By W. J. RICHARD

MINERAL-INSULATED cable has been used extensively abroad for many years; however, its use in the United States is relatively new. The inherent nature of this cable enables it to offer distinct advantages and unusual dependability as a wiring system for general industrial use, as well as for many special conditions and requirements.

This cable is unique in that it contains no organic material, which gives it extremely stable properties. Only two inorganic materials are employed in its composition; it is completely non-flammable; it provides a complete self-contained wiring system without the necessity of additional mechanical protection; and it is capable of withstanding some unusual service conditions which would be highly destructive to other types of cable.

Type MI cable is relatively light in weight, small in diameter, physically tough and may be bent with ease to make it conform to structural shapes and to the irregular contours of equipment. Its physical nature enables it to readily accommodate a wide range of installation and operating conditions.

Materials and Manufacture

Materials employed in the manufacture of type-MI cable are copper and magnesium oxide. The copper is used for the conductors and for the outer sheath. The magnesium oxide, in dehydrated form, is used for the insulation. In the finished cable, the conductors are properly spaced and the highly compressed magnesium oxide insulation completely fills all of the space within the sheath around the conductors — to provide a compact cable construction.

The two principal steps involved in the manufacture include, first, the preparation of the "starting assembly," or the fitting together of the sheath, the insulating material and the conductors. The second step involves a succession of drawing operations through dies, with intermediate and final annealing operations. The die-drawing operation is basically the same as employed in conventional wire drawing except for the much larger diameters.

The outer tube (or sheath) is, of course, the only part of the assembly that comes in direct contact with the dies. The compressive forces from the action of the dies on the sheath are transmitted through the magnesium oxide to the copper rods, so that the entire assembly is reduced in cross section area and increased in length in the same proportion, without changing the relative position of the component parts with respect to each other. This drawing operation is repeated through successively smaller dies until the final desired size.

As the complete assembly is drawn down, the copper sheath and conductors increase in hardness due to the cold working of the metal. Because of this action, it is necessary to anneal the assembly at intervals between the drawing operations. The last operation, after coiling the finished cable, is a final anneal. This provides soft copper, to facilitate bending during installation. It is apparent, from the method of manufacture, that the finished cable is dense and compact in nature and this enables it to be bent during installation to a relatively small radius without difficulty.

Sections of the component parts of a "starting assembly" are shown in Fig. 1 for a two-conductor cable. A short length of finished cable in size 14 AWG, with the two conductors exposed at one end, is included to show the reduction in size from the initial assembly to the final product.

MI Cable Specifications

Type-MI cables, rated at 600 v, for power, lighting and control purposes are available in single, two, three, four and seven-conductor constructions. The four- and seven-conductor cables are used primarily for control and indicating circuits, and the others for power and lighting.

In addition, a special two-conductor 300-v cable, employing a resistance alloy for the conductors, is manufactured for electric heating applications.

The range of type-MI cable sizes and dimensions for each construction is shown in the table. This covers the minimum and maximum conductor size for the single, two, three, four and seven-conductor constructions. Intermediate sizes are available between the two limits shown in this table.

It is quite apparent from the method of manufacture that the practical, continuous coil lengths of completed cable are controlled by the mass of the starting assembly and the size of the finished cable. The starting

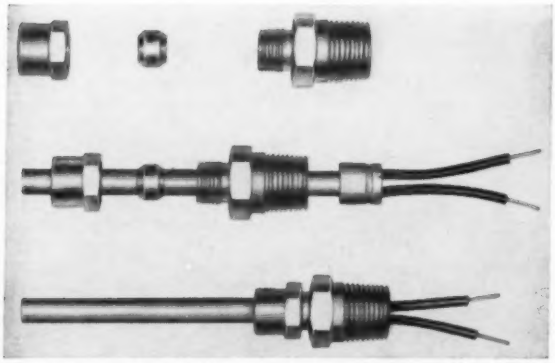

Fig. 3. Complete MI Connector assembly. Parts shown are placed on cable prior to applying Seal Termination unit

Showing MI Cable-Range of sizes and dimensions for each cable

CONDUCTORS			COMPLETE CABLE		
Number Cond's	Size (AWG)	Diam (in)	Diam (in)	Weight (M ft)	Coil Length
1	16	.051	.215	80	1950
	4/0	.460	.699	1090	175
2	16	.051	.340	170	720
	4	.204	.684	760	170
3	16	.051	.355	195	675
	4	.204	.730	925	150
4	16	.051	.387	210	555
	6	.162	.684	825	170
7	16	.051	.449	300	480
	10	.102	.621	675	250
(Above figures are for 600 v)					
300-v Heater Cable					
2	18	.038	.246	86	1300

assemblies for all cables have somewhat similar mass; consequently, the final continuous lengths of the large cables are less than those of the small cables as shown in the table. It is also evident that the method of manufacture lends itself only to the production of solid conductors.

Resistance to Heat and Cold

The only high-temperature limit on type-MI cable in short-time exposures is the melting point of the copper components, or 1083 C (1981 F). The magnesium oxide insulation is stable and unaffected by temperatures up to 2800 C (5072 F), which is the fusion point of the material. For continuous operation, the maximum recommended temperature is 250 C (482 F). Operation at higher continuous temperatures appears likely to cause progressive oxidation of the copper sheath and reduced sheath life. Cold temperatures have no effect on the cable and there is no practical limit on low-temperatures for installation or operation.

Resistance to Flame

Since type-MI cable contains no combustible materials, it is completely non-flammable and cannot generate any toxic, combustible or explosive gases due to heating. With its ability to withstand very high temperatures, combined with the fact that it cannot burn, this cable offers a maximum reliability in the case of external fires, in that it will not convey flame and will continue to operate at temperatures far beyond the capability of other types of cable.

Other Advantages

Since the components of type-MI cable are completely inorganic, the cable is not subject to decay, rot or normal aging influences. Its properties remain stable through its use.

The impervious copper sheath provides complete protection from most industrial environments. Copper is more resistant to corrosion than most metals in common use; the sheath provides the cable with complete protection from direct exposure to moisture, hot and humid atmospheres, sunlight and ozone. The end seals prevent the entrance of moisture into the cable ends. The cable is highly resistant to greases, oils, fats, soaps, alkalies, water, gasoline, solvents, and some acids. The ability of the cable to withstand unusual or questionable environments may be reliably determined by previous experience with other copper products, such as tubing, bare conductors, copper fittings, etc, used in the same environment.

Physical Qualities of Cable

In the final annealed state, type-MI cable is easy to bend, yet it is rigid enough to retain the shape to which it has been trained. The exceptional ability of the cable to withstand severe mechanical abuse such as impact, twisting, crushing and bending has been fully demonstrated by tests, as well as by field experience. Its rugged physical properties permits its use as a self-contained wiring system without the necessity of additional mechanical protection of any kind.

The magnesium oxide insulation in type-MI cable has excellent insulating properties, and is also a good conductor of heat when tightly compressed. The dielectric strength is less than for new conventional rubber or thermoplastic insulations, but is adequate for 600-v service and remains stable throughout its life. The insulation resistance is higher than any extruded insulation in general use, except polyethylene. It has a very low power factor which compares favorably with polyethylene and its dielectric constant is lower than most rubber insulations. Its rating is limited to 600 v for power and control applications.

Method of Installation

Over-all diameter of type-MI cable is much less than for conduits required to carry equivalent circuits. The much smaller space occupancy of the MI cable greatly simplifies many wiring jobs in congested areas otherwise made difficult because of the limited available space for the wiring installation.

Technique of installing type-MI cable is simple and easily learned. The cable is shipped in standard factory lengths in large diameter coils tagged for footage, cable size and construction. Each coil is wrapped with reinforced paper as a binder and a protection during transportation and handling. The cable ends are factory sealed to prevent the dehydrated magnesium oxide insulation from absorbing moisture.

When the new cable is cut it is advisable to reseal the remaining cable in the coil if it is not to be used soon; and, the permanent seals should be applied to each cable run as promptly as possible. The distance that moisture will penetrate into exposed ends of the cable is a function of time and conditions of exposure, but under the worst conditions the distance is limited to approximately two feet. The affected insulation will normally be removed in the process of stripping the sheath back and terminating. The absorption of moisture by the insulation does not permanently harm it.

Then, if the moist insulation is not completely removed when the sheath is stripped back, the initial properties can easily be restored by applying a torch to the short end affected, to drive off the moisture. The most convenient method to check the ends to see that they are free of moisture is by insulation resistance measurements. Dry insulation will give very high readings, whereas if the ends are wet the readings will be low.

Keeping the cable straight when unwinding the coil facilitates final training. It may be fastened directly to any wall, structural steel, woodwork or machine frames, by means of clips, conduit hangers, straps or brackets. It may also be supported in trays, racks, or in messenger rings. Since the cable is fully annealed at the factory, it is easy to train into the desired position. Bending may be accomplished by hand, or it may be hammered in place with a wooden mallet. Standard conduit "hickeys,"

or bending tools, may be used for bending the larger sizes. The cable may be bent for installation to a radius as small as 5 times the cable diameter.

Standard junction, or outlet, boxes may be used at each termination or when two lengths of cable are joined together. The terminations may be made up either before, or after, the cable is placed in final position. Where there are a number of standard lengths or shapes, the cable may be formed around a template, and the terminations applied at a work bench before the lengths are placed in final position. The nature of the installation and the field conditions usually dictate the best procedure to follow.

It is apparent that since there is no ultimate wire-pulling operation there are no practical limitations on the length of runs or the number of bends that can be made when installing type-MI wiring systems. The installation simply involves the training of the cable in the desired position, the installation of the necessary supports, and the application of a seal at each end of the cable.

Standard fittings for terminating MI Cable are available from the cable manufacturers. These include a cable-seal termination (to provide a moisture seal and to insulate the bare conductors), and a threaded gland to provide a means of securing the end of the cable to a standard outlet or distribution box.

Cable Seal: Basic parts of the cable-seal termination and the complete seal are shown in Fig. 2. The following parts are required for making the seal.

1. "Screw-on-pot", a self-thread-brass cylinder
2. Neoprene tubing, for insulating the exposed conductor ends
3. Insulating cap
4. Sealing compound, a soft plastic material
5. Crimping and stripping tool

The cable-seal termination is made by removing the copper sheath with the stripping tool to expose the length of conductors needed for the connections; screwing the self-threading "screw-on-pot" onto the end of the cable sheath; filling the pot with sealing compound; threading the neoprene tubing through the holes provided in the insulating cap; slipping the neoprene tubing and cap assembly over the exposed conductors and pressing the cap down into the end of the "screw-on-pot"; and, finally, screwing in place by crimping the edge of the pot down over the insulating cap. This insulates the end of each exposed conductor and provides a moisture seal over the insulation.

Threaded Gland: Fig. 3 shows the parts of the threaded gland, with the gland in place before tightening; and, finally, with the gland locked in the final position. The following parts are included:

1. Gland body
2. Compression ring
3. Gland nut

These gland parts are slipped over the end of the cable before the termination is applied, in the order of: first, the gland nut; then, the compression nut; and, finally the gland body. When the gland nut is screwed into the gland body over the compression ring, the ring is compressed onto the cable sheath which anchors it into position. This can be applied at any point on the cable, but usually it is brought clear up to the end with the cable-seal termination seated into the counterbored end of the gland body. The outer end of the gland body is threaded for lock nuts.

Recognition as Approved Cable

Mineral-insulated wiring was first incorporated in the National Electrical Code in 1953, after a very extensive evaluation by the Underwriters' Laboratories, Inc, under the designation of "Type MI Wiring." Paragraph 3302 of the Code, entitled "Use," states that the cable may be used for services, feeders and branch circuits in both exposed and concealed work, in dry or wet locations; for under plastic extensions; and embedded in plaster finish on brick or other masonry. It may be used where exposed to weather or continuous moisture, for underground runs and embedded in masonry, concrete or fill, in buildings in course of construction or where exposed to oil, gasoline, or other conditions not having a deteriorating effect on the metal sheath.

Type MI wiring is also included in the later editions of the Code. It is recognized for general use at a maximum operating temperature of 85 C (185 F). This temperature is fixed

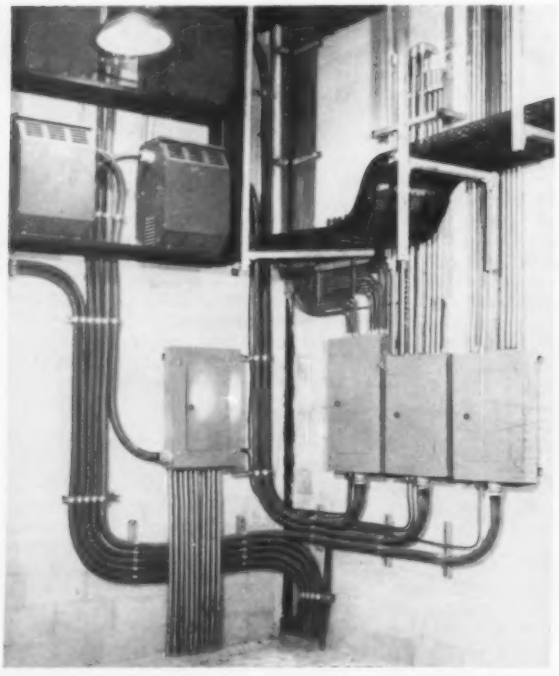

Fig. 4. Typical installation of MI cable, together with interlocked armored cable, in a large paper plant in Florida

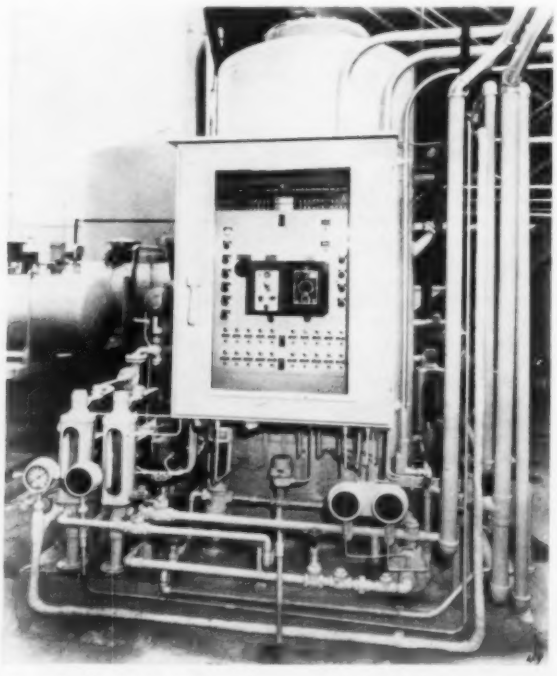

Fig. 5. MI cable installed on water treatment equipment, in a power plant. Note unusually compact arrangement

Fig. 6. Shipboard MI cable installation. These twenty-five cables are part of power and control system on the *Santos*

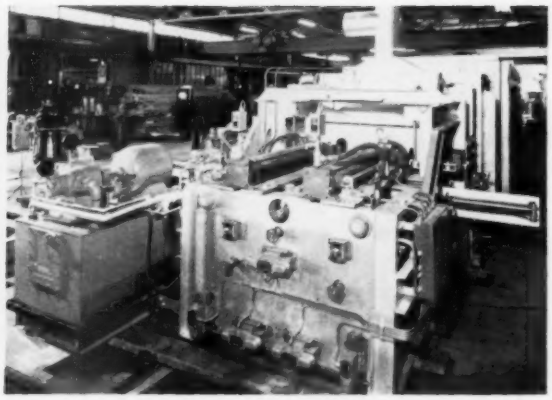

Fig. 7. Typical machine installation. Here is example of MI cable, installed in very limited space, on an electric furnace

mainly by the temperature capabilities of the approved terminations and not by limitations of the cable itself. The Code does permit MI wiring to be operated at a maximum temperature of 250 C (482 F) for special applications, such as in local hot spots where the cable terminations do not exceed the stipulated 85 C.

The latest AIEE-45 Standard for "Recommended Practice for Electrical Installations on Shipboard" recognizes MI cable as an approved type of wiring for all classes of mercantile vessels.

Two types of coaxial cables are approved by the Armed Services under JAN-C-17A specifications for use at radio frequencies for continuous operation up to 250 C (482 F.)

W. J. Richard graduated in Electrical Engineering at the University of Maryland in 1924. The first five years after graduation he was employed in the Utility field, on distribution design and high voltage transmission engineering. He then joined a large engineering and construction company, and continued to specialize in high voltage transmission, and special studies associated with power station design, and electrolysis investigations.

For the past twenty-three years he has been associated with General Cable Corp. After spending one year in the Research Laboratory, he became Eastern District Sales Engineer; and six years ago was made Assistant Chief Engineer for the company.

Industrial Uses For Cable

The principal use of type-MI cable in this country is in the industrial field, and by Utility companies for power lighting and control circuits. It is also being used quite extensively for shipboard use for the wiring of large ocean-going oil tankers in particular. Although MI wiring has been the solution to many difficult industrial wiring problems, where conventional types of wire would not withstand the temperatures or other destructive conditions encountered, its unusual capability only adds to the broad scope of its use. First of all, it is selected for many important installations for normal use on the basis of its dependability.

In addition, it meets many other industrial wiring needs, including ease of installation, adaptability to the rearrangement or relocation of circuits, ease with which new circuits may be added, neat appearance, small space occupancy, and excellent physical and electrical properties.

Another special feature, not previously mentioned, is the ability of MI cable to withstand exposures to atomic radiation which would be destructive to other types of wiring.

MI cable is being used in the plants of many leading industries including oil, chemical, steel, automotive, paper, utilities, railroads and others.

Typical Installations

Figure 4 illustrates the general use of type-MI cable for distribution circuits, while interlocked armored cable is used for the main feeder circuits. This installation is in the substation of a large paper plant in Florida.

Figure 5 illustrates the use of type-MI cable on water treating equipment of the Illinois Water Treatment Co, for an installation at Ninemile Point Station of the Louisiana Power & Light Co. This again shows how MI cable can be used to advantage for equipment wiring where space is limited, and it is highly desirable to follow the contours of the equipment. This can easily be accomplished with MI wiring, with a final neat appearance and a high degree of dependability.

Figure 6 is an installation of type-MI cable on the Atlantic Refining Company's tanker *Santos*. This illustrates the confidence of ship owners in the suitability of MI cable for exposure to weather and water where service reliability is of primary importance. This waterproof property is also important for installations such as in dairies, breweries, food industry, pulp and paper plants, where the normal conditions are wet, and where water or steam washdowns are frequent.

Figure 7 shows type-MI wiring being used on an electric furnace installation in New Jersey. This illustrates the ability of type-MI to withstand high temperatures, and also shows how well it can be trained on, and around, equipment. For installations where the cable must be terminated in hot zones beyond the temperature capability of the standard Underwriters' approved 85 C termination, special high-temperature terminations are available. Experience has shown, however, that standard terminations can be employed in most cases, by keeping the terminations away from the hot zones.

Type MI wiring is filling many of the normal and special needs of industry with a high degree of reliability. The technique of installation is simple and easily learned. It provides a complete self-contained wiring system without the necessity of additional mechanical protection. For more information, write the Editor, or jot MI-Cable on the Inquiry Card in this issue. THE END

More Data on Heat Pumps

First part of this authoritative article on heat pumps appeared last month. Basic principles of operation were discussed in detail; now actual installation data are given to show proof of economy

By J. R. HARNISH* and R. C. NIESS*

FROM THE electric utility standpoint, heat pumps appear to be a very excellent load. Electrical load factors improved by heat pump installations will help utilities realize sufficient income during what are now generally considered off-seasons.

Figure 4 in Part I of this article shows that for the year 1957, the peak winter demand for the heat pump was within four per cent of the peak summer demand. This should help dispel previous thinking in some quarters that a 33 per cent saturation of the heating market with heat pumps would be the ultimate from the standpoint of leveling summer and winter peaks, at least as it applies to the industrial heat pump market.

Furthermore, over the nearly two-year period, the minimum monthly building electrical demand encountered represented 78 per cent of the maximum monthly demand. However, had a fossil-fuel-fired heating system been installed, the minimum electrical demand would show an appreciable dip to 57 per cent of the peak.

An analysis of the yearly electrical consumption indicated that the total building, with the heat pump, distributed 48 per cent of the consumption during the heating season and 52 per cent during the cooling season. Had a combination oil, or gas-fired, heating system, plus cooling system, been installed, only 42 per cent of the consumption would have been used during the heating season, and 58 per cent during the cooling season.

This dramatically illustrates the favorable leveling effect on the load factor to the electrical utility. From the customer standpoint, these improved load-factors will benefit him in lower electrical costs for both the heat pump and the overall building power consumption. For the utility, installed generating and transmission equipment can be more fully loaded throughout 12 months of the year.

Figure 1 shows the recorded heat pump demand correlated to the hourly outdoor temperature over a one-week period from January 16 thru January 22, 1957.

Several observations of interest can be made concerning this correlation. During protracted cold spells (the outdoor temperature did not go above freezing from January 16 thru January 18) it can be seen that the heat pump required the largest block of power for the week. Note that the minimum outdoor temperature of 13 F occurred for about eight hours on January 17, coincidental with the peak of 109 kw. This 13 F temperature also was the lowest sustained cold period during the entire 30 days, as was the 109-kw peak heat pump demand for this period.

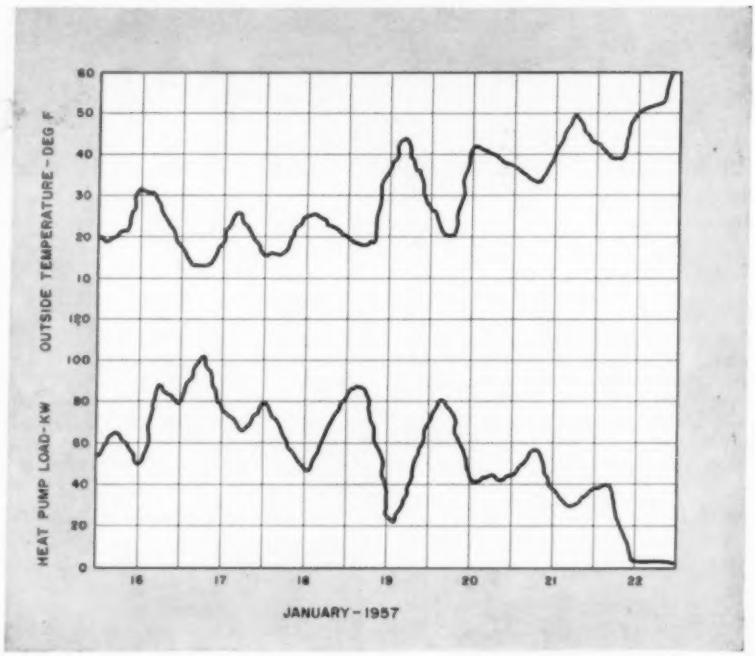

Fig. 1. Heat pump electrical demand and outside temperature, for cold week during January, 1957. Note that demand varies inversely as temperature changes

Starting on the morning of January 22, a continual rise in temperature from 38 F to over 60 F was experienced. In reacting to this condition the heat pump system shut down and automatically increased quantities of outside air, providing the cooling now necessary in the conditioned spaces.

As shown in Fig. 1, the daytime peaks are relatively constant throughout the 30-day period for the six days a week of store operation. The valleys occur during hours when the store is closed and the majority of lights and fixtures are not in use.

In addition to providing factual data concerning the actual operation of the Heironimus heat pump system, the recorded data presented an opportunity to compare with estimates.

The York Corporation estimated the performance of the heat pump, using a detailed weather analysis based on average weather conditions as previously mentioned. Table I shows the *actual* versus *estimated* consumption. The estimated figures are shown two ways. First, the estimated performance based on average weather conditions is indicated. This same information was later pro-rated to correct for the actual weather conditions experienced.

This comparison indicated the methods used in estimating performance resulted in a reasonable prediction. The slightly conservative estimate can be attributed to several unpredictable influences, such as solar effect and heat dissipated by the occupants. These unpredictable influences provide an adequate margin to offset an unusually cold winter. Over the heating season, in this particular instance, the actual electrical consumption of the heat pump system ran approximately six per cent less than estimated. Also, on this installation, the actual consumption was about 13 per cent less than that predicted for average weather conditions, as the actual degree-days were approximately 7 per cent less than average for this period. This further indicated that even with variable

* York Division of Borg-Warner Corp

weather conditions, reasonable predictions can be made.

Winter Cooling Required

At the outset, check meters were installed to record demand and kwh consumption of the heat pump performance. These recorded the cycle operation, whether heating or cooling, but not separately. Subsequent observations indicated that some cooling was required during the heating months, due to infrequent high outside temperatures; even above the point where the economizer function of using up to 100 per cent outside air would handle the cooling requirement. Consequently, the data obtained for the first 19 months of operation did not fully indicate the true economy of the heat pump system.

In the latter part of November 1957, check meters were installed to record heating and cooling operation separately. The results of this separate metering, as shown in Table II, bear out the observations concerning the need for cooling even during winter months. For the particular months recorded (December 1957 thru February 1958) the actual degree-days were approximately 10 per cent greater than normal, indicating that during average months even more cooling might be expected.

Operating Cost Experience

Another compound-compression air-source heat pump installation went into operation in the summer of 1956. This system provided year-round conditioning in an owner-occupied office building.

This new home office building for the Ballinger Co, Architects and Engineers, located in downtown Philadelphia, is a contemporary two-story structure having 15,840 sq ft of floor space. Heat-absorbent glass walls extend from the ceiling of the first story to the top edge of the roof.

Fig. 2. Automatic controls handle climatic situations in Heironimus building

Table I. Comparison of estimated and actual power consumption, as adjusted

Heating Months	Kwh Estimated Consumption: Average Weather Conditions	Kwh Estimated Consumption: Pro-rated To Actual Weather Conditions	Actual kwh Consumption
November 1956	50,694	45,172	38,592
December 1956	51,406	44,464	44,064
January 1957	59,414	57,667	59,616
February 1957	48,720	45,308	48,096
March 1957	32,800	33,651	24,480
TOTALS	243,034	226,262	214,848

Table II. Comparison of heating and cooling cycles, during coldest winter months

Period	Heat Pump Operation: Heating	Heat Pump Operation: Cooling	Actual Degree-Days
12/9/57—1/9/58	45,792 kwh	3,744 kwh	870
1/9/58 —2/10/58	55,008 "	—	967
2/10/58—3/10/58	47,520 "	1,728 "	785

Table III. Heating cost comparison between gas, oil and heat pump sources of heat

Month	The Ballinger Company Philadelphia, Penna. — Comparison of Heating Costs*: Estimated: Gas	Estimated: Oil	Estimated: Heat Pump	Actual**: Heat Pump	Normal Deg.-Days
January	$ 438	$ 449	$ 395	$ 416	933
February	358	365	352	324	837
March	337	342	284	211	66.
April	211	210	158	147	369
May	50	48	40	27	93
June-Sept.	Cooling Only				33
October	143	129	94	54	219
November	268	271	221	212	516
December	360	379	361	343	856
TOTALS	$2165	$2193	$1905	$1734	4523

* Includes operation of all electric auxiliaries used for heating
** Actual heat pump operating costs pro-rated to normal degree days of 4523 for comparison

The heat pump equipment is installed in the partial basement, with an outdoor air cooler-condenser on the building roof. Three indoor air-handling units, totalling 20,800 cfm, each serve a separate zone. Concealed ducts and ceiling-type diffusers supply the spacious and attractive drafting rooms with air at just the right temperature. Private offices are independently treated, using floor-mounted fan-coil room units equipped with combination hot, and chilled-water coils.

The heat pump system is automatic in operation, pneumatically controlled to provide 45 F water for summer cooling, and 115 F water for winter heating. Changeover from the cooling to the heating cycle is accomplished by the flip of a single switch. Water is circulated to the various air-handling units.

In the Ballinger Co building, 2400-v primary service is purchased from the Philadelphia Electric Co. A building-owned transformer bank and unit substation are provided in a basement vault, to transform this primary service to 440 v for the heat pump installation, and 120 v for lighting and other uses around the building.

Prior to the decision to install a heat pump in this building, consideration was given to operating economy as well as first cost. A detailed operating cost analysis was made to compare the heat pump with gas, and oil-fired systems. The results of this estimated performance are shown, on a monthly basis, in Table III; it can be seen that the heat pump appeared to be competitive with the other systems. The heat pump operating costs shown include the compressors, outside air cooler-condenser fans and system auxiliaries such as water-circulating pumps and indoor air conditioning unit fans. The gas, and oil-fired system costs include system electrical auxiliaries.

Actual operating experience on this installation, as shown in the table, indicates an economy of operation better than the estimated amount. In this area, power costs for this type installation are in the magnitude of 1¾ cents per kwh. Actual power consumption and demand information on this project were recorded on check metering instruments installed by the serving utility, Philadelphia Electric Co.

Fig. 3. Heironimus department store, Roanoke, Va. First building in country to be air conditioned with two-stage heat pump. Operating data is discussed in text

Cost Trends In Operation

Major factors in the rapid acceptance of the air-source heat pump are the satisfactory results obtained by the increasing number of users, and the effect of cost trends in electricity, coal, gas and oil.

To illustrate this latter point, U. S. Department of Commerce statistics dramatically demonstrate the growing popularity of heating by wire. The trend shown is clearly established, and any savings at today's rate structure can be expected to show even greater economies for the heat pump owner in years to come.

Many prognostications have been made concerning the effect of the depletion of "fossil-fuel" reserves, with predicted requirements exceeding productivity within 15 to 50 years. A solution to the problem of declining fossil-fuel energy is the increased use of nuclear energy — the British Isles being an outstanding example even today.

Authorities in the atomic energy field indicate that the most likely approach is to be found in central power generating stations, remotely located from populated areas, supplying power over existing, and additional, distribution networks.

For space heating, the heat pump with its inherent characteristic of providing from 2 to 5 Btu's of heat for each Btu input appears to offer a solution of effectively utilizing this energy.

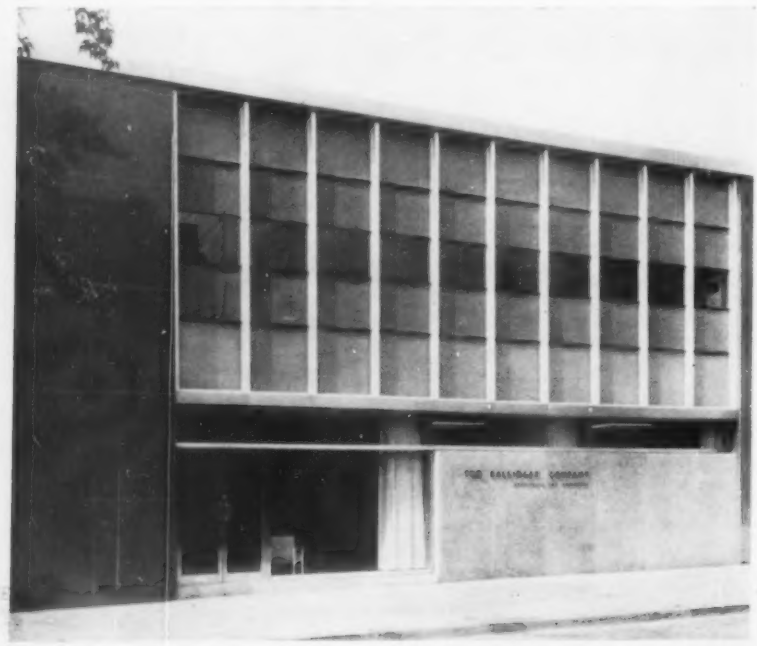

Fig. 4. Philadelphia's Ballinger Building. First northern building to be heated and cooled by a compound-compression heat pump. Freezing air is used as heat source

Acknowledgments

The authors would like to express their appreciation to the many who contributed valuable time and information in obtaining the data presented. The actual operating statistics would not have been possible without the extensive efforts and cooperation of American Gas and Electric Service Corp, Appalachian Electric Power Co, Philadelphia Electric Co, and the Ballinger Co. THE END

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When You Crush and Pulverize Coal

Here's a round-up of the many kinds of machines used for size reduction of coal to particles fine enough for proper combustion. Also included is description of machines for grinding other solids

By U. B. YEAGER*

AN ACCUMULATIVE mass of solid may be broken down by various mechanical separations, such as by screening. This is a common practice in the preparation of coal at the mines. In this discussion we are confining our approach to the physical reduction in size of individual particles or masses. Some features may be common to mining operations and still others at the point of consumption.

Separation of an individual particle or mass into a number of smaller particles or masses may be done in any one or a combination of several ways. A material that may gain much surface easily by one method or size reduction may not be so easily disintegrated or pulverized so readily by another. It is recognized that solid materials have the following properties to some degree, all of which play a part in a reduction of particle size: hardness, bulk density, abrasiveness, adhesiveness and tendency to agglomerate, corrosiveness, dryness, moisture content and wetability, oil content, elasticity, fiber content, toughness, explosiveness, flammability, volatility, plasticity, softening temperature, magnetic properties and capacity for electrical charges.

The combination of methods of reduction and material properties determines the particle shapes. Descriptive terms for these operations seem to vary somewhat according to the use and the industry involved, for materials other than coal, even though the basic characteristics of the operations of the equipment may be quite similar. End result of the product, as well as the procedures involved within the particular industry of which the size reduction process is only one part or a unit operation, must be considered.

Equipment for crushing and grinding (size reduction) can be roughly divided into three general classes. However, because of the large number of materials of divergent characteristics which may be acted upon by the different kinds of size reduction equipment, a sharp line of classification cannot very well be made of the different divisions of separation or size reduction.

Generally, the separations or classes as noted in the descriptions below are from a point approaching the relative intensity with which the individual masses are disintegrated into small particles or classes, as follows:

Coarse, Heavy Duty or Primary Reduction. Under this class the individual masses fed to the machines range in size from less than 2 in. to plus 6 in. with the upper size limited essentially to the mechanical capacity of the feeding equipment. The end product ranges down to about ¼-in. (or 3 mesh). Basically, this is a crushing or breaking of coarse materials.

Intermediate or Secondary Reduction. Under this class the individual masses fed to the machines range in size initially from about 2 to 6 in. while the outlet product ranges down to 20 to 40 mesh. This class is characterized by disintegrating systems involving blows, impacts and crushing rolls.

Fine Grinding or Pulverizing. Under this class the individual masses fed to the machine range normally from about 1 to 3 in. while the final product ranges down to about 200 to 325 mesh in size. Reduction or disintegration is accomplished largely by grinding, attrition or abrasion. Here again, if we consider coal alone, a normal operation approaching the rated capacity of the equipment probably will have a coal feed to the equipment such that no more than about 35 to 40 per cent will exceed 1¼-in. in top size.

Ultrafine Reduction. This is really a division of Fine Grinding, having a limited range of feed from about ¼ to ⅜-in. and an end product of from 100 mesh to 2500 mesh in size. In pulverized coal-fired practice an excessive amount of ultrafine particles is a needless waste of operating capacity, time, labor, power and handling costs.

Distinction in the types of equipment noted for the three main classes of size reduction cannot be sharp, for it has been found that the same basic type of equipment, as for example hammer mills, may appear under all three classifications of size reduction.

Preparation of finely divided solids involves physical size reduction or disintegration by machines or mechanical processing equipment. This mechanical reduction of material sizes is achieved essentially by a

This table indicates the various kinds of size reduction equipment used for crushing and grinding solid materials into the three classes. Numbers refer to text

	Primary or Coarse (Down to 3M)	Secondary or Intermediate (3M to 40M)	Fine (Under 40M)
Bark	3, 7, 9, 11, 27	3, 9, 11, 13, 20, 27	9, 27
Carbon activated	5, 7, 9	3, 9, 11, 17, 20, 21, 27	9, 11, 14, 15, 16, 18, 19, 20, 21, 24, 27
Carbon, graphitic	1, 2, 3, 9	3, 5, 9, 10, 11, 14, 15, 16, 17, 20, 27	9, 10, 14, 15, 16, 18, 19, 21, 22, 24, 26, 27
Cement (clinker or rock)	1, 2, 3, 4, 5, 6, 7, 9, 14, 15	3, 4, 5, 9, 11, 14, 15, 18	9, 11, 13, 14, 15, 18, 19, 20, 22, 23
Charcoal	3, 4, 5, 7, 9, 16	3, 7, 9, 11, 19, 20, 21	7, 9, 11, 14, 15, 16, 18, 19, 20, 21, 22, 23, 26
Coal, anthracite	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	3, 4, 5, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 25	3, 4, 5, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 25
Coal, bituminous and lignite	1, 2, 3, 4, 5, 6, 7, 8, 9, 14, 15, 18	3, 4, 5, 6, 7, 9, 10, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 25	3, 7, 9, 10, 12, 13, 14, 15, 16, 18, 19, 20, 22, 23, 25
Coke, bituminous	1, 2, 4, 5, 6, 7, 8, 9	3, 4, 5, 9, 10, 13, 14, 15, 17, 18, 20	3, 4, 5, 9, 12, 13, 14, 15, 16, 17, 18, 20, 22, 23, 25
Coke, petroleum	1, 2, 4, 5, 7, 8, 9, 17	3, 4, 5, 9, 10, 14, 15, 18, 27	4, 5, 9, 10, 14, 15, 16, 17, 18, 20, 22, 23, 25
Slag	1, 2, 3, 4, 5, 9	3, 4, 5, 9, 14, 15, 17, 18, 20	3, 9, 14, 15, 18
Wood Chips	9, 27	9, 11, 20, 27	9, 14, 15, 18, 20, 27

*Fuel Engineer, Island Creek Coal Sales Co. Huntington, W. Va. Mr. Yeager's first article on basic considerations when burning pulverized coal appeared in the May issue of POWER ENGINEERING

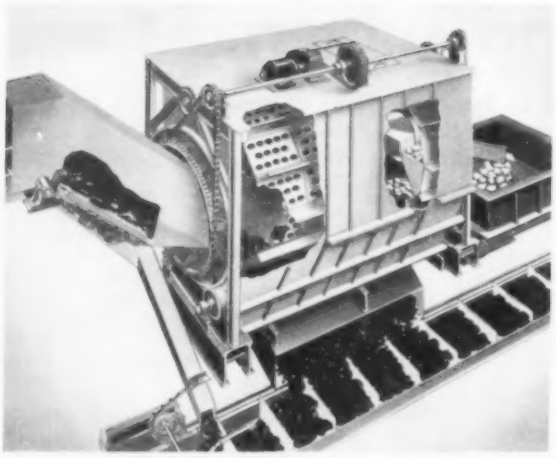


Fig. 1. Rotary breaker has heavy perforated liner of breaker plate. Material is discharged by gravity along bottom

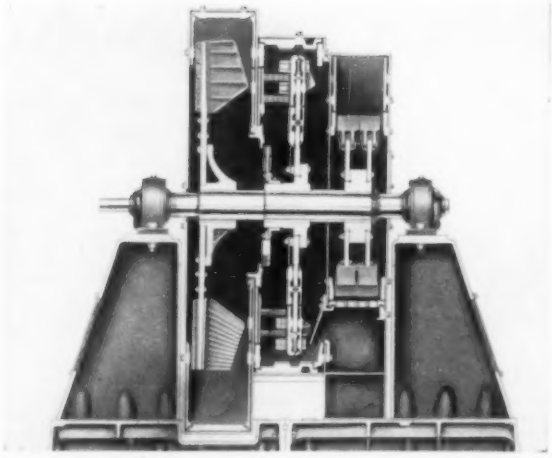


Fig. 2. Attrition-type mills have disks operating in vertical planes. Material may be removed by pneumatic air system

number of operations noted here:

Attrition is the act of rubbing together and wearing or grinding down by friction or abrasion.

Breaking is the separation into parts by concussion or sudden and violent stress as distinguished from a gradual process.

Bursting is a particle breakdown by a pressure system in which the internal pressure is greater than the external pressure.

Crushing is a reduction in size by a violent compressive force by pressure.

Cutting as a reduction process is to cleave, sever, carve, gash or slash with an edged instrument.

Flaking is a disintegration of sizing into flakes, chips or scale-like particles or masses.

Grinding is a reduction by friction with the particles pressed and rubbed harshly.

Pulverizing is to separate the mass into very small finely divided particles by beating, grinding, rubbing, crushing, breaking, attrition, etc.

Shearing is to cut sharply with an internal force tangential to the section on which it acts. It is a transverse force causing two contiguous parts of a body to slide relative to each other.

Shredding is to tear into fiber-like strips.

Tearing is to divide by violent measures, pulling forcibly apart along a line or surface of juncture.

Wave-length breakdown is a separation by sonic and/or ultrasonic waves acting upon the masses or particles.

Regardless of the methods or materials used, any disintegration of the basic masses to a degree of fineness beyond that which may be required, or is necessary for a proper or satisfactory completion of the process involved, simply reduces the capacity of the size reduction mill or equipment and increases the power costs, labor costs per unit of output and maintenance costs.

Various types of size reduction equipment and their basic principle of operation are briefly noted below.

1—Jaw Crushers

Jaw crushers operate on the principle of crushing the material between two heavy jaws, one of which is fixed or stationary and the other of which is movable. There are two basic types.

The Blake-type crusher is so designed that the movable jaw is hinged at the top, thereby giving the maximum travel of the jaw at the bottom. On the back stroke, the crushed material drops freely from the jaws.

The Dodge-type crusher is somewhat similar in action and construction to the Blake except that the movable jaw is hinged at the bottom, giving the maximum pressure at the bottom with the resulting minimum pressure at the top. There is a tendency for this type of crusher to become jammed or choked with fines at the bottom or point of discharge of the crushed material.

With either type, the fixed jaw may either be vertical or slightly inclined. Faces of the jaws may be relatively smooth or corrugated.

2—Gyratory Crusher

Gyratory crushers are built in the manner of two truncated cones, the center cone moving within the outer shell or cone, which is fixed and inverted from the standpoint of the center cone. Center cone, hinged or pivoted about an extension from its upper point, has a wobble or irregular movement given to it by an eccentric gear train at a bottom extension. Wobble movement gives to the crushing or grinding surfaces an action which, in some respects, is similar to a Blake crusher except that the crushing action is entirely around the crushing head with each complete cycle or rotation of the gear train. Crushed material feeds downward by gravity.

3—Cone Crushers

In many respects a cone crusher is similar to a single-roll crusher but one having a conical-shaped roll rather than one of cylindrical shape. The crusher plates, of course, are conically shaped in order that they may receive and contain properly the action of the rotating cone.

4—Single-Roll Crusher

Single-roll crushers, in general, may be considered essentially as being made up of a rotating horizontal cylinder and a fixed crushing plate or surface. Rotation of the cylinder toward the plate crushes the material against the fixed or stationary crushing face or breaker plate. Cylinder roll may be relatively smooth or corrugated or covered with various arrangements of lugs and/or teeth.

5—Double-Roll Crusher

A double or two-roll crusher is built essentially as two horizontal cylinders or rolls revolving in opposite directions with respect to each other but toward each other from above or from the standpoint of the feeding of the material downward by gravity to the crushing faces. Crushing or breaking action is obtained between the crushing rolls. These rolls may be smooth, ribbed, corrugated or fitted with teeth, both normal and slugger type. Size of the product from the rolls is determined by the clearance adjustment between the teeth and the rolls.

6—Rotary Breaker

Rotary breaker, of which the Bradford breaker is one type, is essentially a hollow cylinder whose center line is at only a very slight elevation from

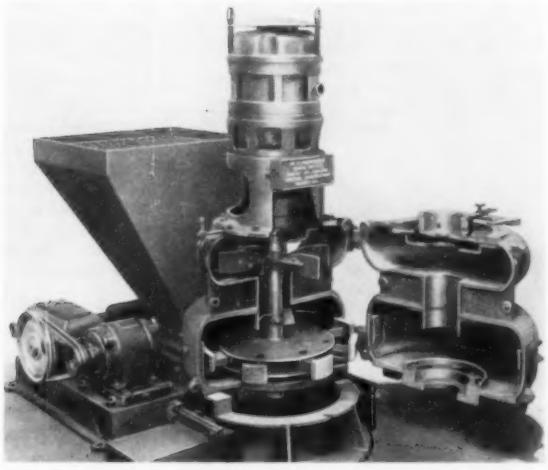


Fig. 3. Hammer mills consist basically of series of disks between which are placed either hinged or swing hammers

a horizontal line. This breaker has a heavy perforated screen-type liner or breaker plate the inner walls of which are smooth or corrugated or have narrow ledges extending the length of the cylinder.

Material is fed into one end and is discharged by gravity along the bottom central section of the housing. Reduction in the size of the material is brought about by the tumbling action of the material during the rotation of the cylinder. Continuous screening operation removes undersized material. Large pieces of stone are carried through the breaker and are discharged separately at the end opposite the feed.

7—Saw-Tooth Breaker

Saw-tooth breaker or crusher is similar in action to a double-roll crusher except that the teeth are so set or spaced in circular planes as to give the effect of a number of intermeshed circular saws, which effectively accomplish the reduction.

8—Pick Breaker

Pick breaker is made up of several sharp pointed picks or teeth extending downward from an overhead plane. In action, the material is advanced literally to a point under the plane. The picks or teeth then are moved downward and pierce or prick the material in such manner as to break open the larger pieces of material. The teeth or picks are then raised and as the broken-up material is moved forward from beneath the system of teeth, fresh material is moved into place, and the cycle is repeated.

All of the above types of equipment are of use mainly with coarse or primary grinding and crushing and except for the single and double-roll crushers are more likely to be found in mining than in power plant use.

9—Hammer Mills

This term is applied to a rather wide variety of mills used for crushing, shredding and pulverizing. Basically, they are made up of a series of disks or plates between which are placed either hinged or swing hammers, or fixed hammers or bars.

Generally, the axis for these hammers is horizontal, but in some types the axis may be vertical, in which case the hammers swing or move in horizontal planes.

Breaker plates for the conventional hammer mill are on the lower half of the mill, for those mills having the horizontal axis. Impact of the hammers against the material drives it against the breaker plates or screen bars until it has been sufficiently beaten around or so reduced in size as to pass out through the screen. By using screen bars of different cross-sections, and by the design in shape and weight of the hammers, either brittle or fibrous materials may be processed.

10—Impact Beater Mills

Impact or beater mills are basically special types of or applications of hammer mills. Overall application possibly would be for softer types of materials than would be normal with the conventional hammer mills, or for materials of smaller entering or feed size.

11—Rotary Knife Cutters

Rotary knife cutters might be likened to single-roll crushers but with two, three or four cutting bars or knives extending lengthwise of the rolls' outer surface and parallel to the axis of rotation. In action the rotary motion of the mill cuts the material between the knives and the cutting plate or surface.

12—Cage Mill Disintegrator

A cage-type mill or disintegrator is constructed of one or two vertical movable disks mounted on a horizon-

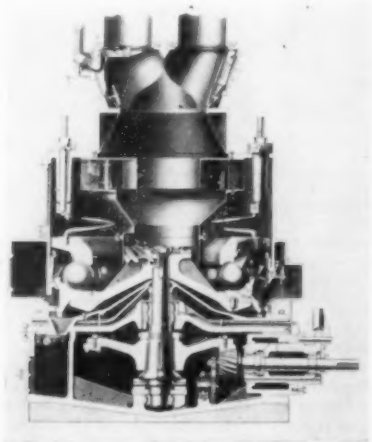


Fig. 4. Ball and race mill is similar to a very large ball bearing in action

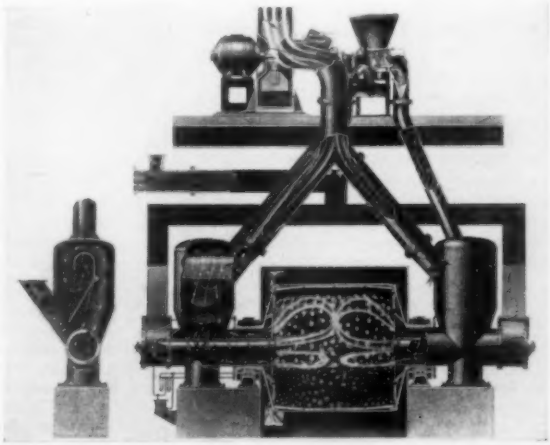


Fig. 5. Ball mill has steel balls as additional grinding medium during the tumbling action, reduces more finely

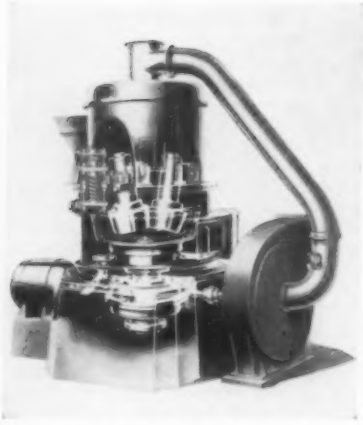


Fig. 6. Bowl mill has grinding chamber which revolves around rolls on shafts with nearly vertical bearings

tal shaft and all within a suitable housing. The disk and housing plate, or the two disks, are separated by an interval suitable for the desired processing.

On the inner faces of the disks (if two disks are used) are mounted a number of rods or pegs arranged in circles of different radii so that in movement the pegs or rods travel in concentric circles. Fibrous materials, such as packing house waste for manufacture into fertilizer, may be processed, or other such materials which are not too hard but are friable (such as coal and limestone).

13—Coffee Mill

Coffee mill type of grinder for commercial application is similar in many respects to a small vertical cone-type crusher but appears to be more for small-scale reduction both as to size of feed materials and size of end product particles, as well as in the capacity or amount or rate of materials processed. This equipment is quite well adapted for laboratory use.

14–17—Ball, Tube, Jar, Rod Mills

Ball mills, tube mills, jar mills and rod mills have so much in common that they are treated here together. Basically, they are similar to the rotary mills except for the fact that size reduction is made more positive by the addition of steel balls, pebbles or rods as an additional grinding medium during the tumbling action, and the end product is more finely reduced in particle size.

Length of a ball mill is usually but not necessarily equal to its diameter, while the length of a tube mill is always greater than its diameter. Ball mills filled with a certain amount of steel balls or certain types of hard pebbles are used for either continuous or batch-type operation.

Jar mills are smaller-type mills made of heavy porcelain-like materials, and function solely for batch-type operations in relatively small amounts of the material being processed. While these jar mills have been extensively used in laboratory work, their use for the preparation of coal samples has not been found to be fully satisfactory where accuracy is desired.

Conventional tube mills contain steel balls or pebbles, but where the grinding is sectionalized within the mill, they are known as compartment-type mills.

Rod mills are similar to tube mills in design, but the grinding medium is made up of rods instead of balls or pebbles. These rods are of varying diameter and of a length approximately equal to the inside length of the mill.

18—Ring Roll Mill

The ring roll mill is characterized by a relatively large grinding ring which rotates in either a horizontal or vertical plane. Normally, three or more rolls are arranged so as to press against the inner circumference of the ring. Material to be ground, therefore, is rubbed and/or rolled between the rolls and the ring.

19—Roller Mills

Roller mills are made up of one or more pairs of corrugated rolls. Material feeds down by gravity. In a pair, the rolls rotate in opposite directions or toward each other with respect to the material feeding to them. One roll of each pair turns faster than the other, which brings about a shearing action rather than simply the direct pressure resulting in the ordinary crushing rolls. Mills of this type are used extensively for grinding grain into flour or meal. They are suitable, too, for the size reduction of many moderately tough materials.

20—Attrition (Plate or Disk)

Mills of this type are so arranged that for the double-runner type of mill the plates or disks revolve in opposite directions, while with the single-runner type, only one disk revolves and the other disk is fixed. The disks revolve at relatively high speed. Material is fed into the mill at a point between the centers of the disk. The disks operate in vertical planes. During the movement to the outer edges of the disks, the material is reduced to the desired fineness.

21—Buhrstone

This type of mill basically is probably the oldest type of size reduction mill still in use. The buhrstones operate in horizontal planes, and either the upper or the lower stone may be the moving stone, while the other is fixed in place. This type of mill has no application in the coal industry except for limited laboratory use.

22—Bowl Mill

The bowl mill consists essentially of a horizontally revolving bowl or grinding chamber which turns on a vertical driving shaft around a series of two or more rolls mounted on shafts having nearly vertical bearings. The rolls have a very slight clearance, with the die ring even at light loads.

Action of the tapered roll on the tapered ring causes the material being pulverized to work constantly upward and out of the grinding zone into the air stream, which enters the mill below the level of the grinding ring. This air stream dries the material being pulverized and carries out of the mill to the classifier material that has been properly pulverized.

23—Ball and Race Mill

Ball and race mill may be compared in its operating action to a large ball bearing. Several steel balls about 9 in. in diameter rotate between the race formed by two large grinding rings, the upper one of which is stationary and the lower one of which is rotated by a gear train. Tension between the rings and balls is controlled by spring adjustment. Material is ground between the rotating balls and rings. Mill is swept by air of material that has been properly ground or reduced to the desired particle size. Grinding is by rubbing, rolling, crushing, etc.

24—Colloid Mill

This mill is essentially a high speed disintegrator and emulsifier in which immiscible liquids, liquids carrying solids in suspension, pastes, etc, are finely

continued on page 114

ACKNOWLEDGEMENTS

For detailed data and illustrations on the various types of crushers and pulverizers discussed in this article, we are indebted to the following: Allis-Chalmers Mfg. Co; American Brake Shoe Co; American Pulverizer Co; Appleton Machine Co; The Babcock & Wilcox Co (Fig. 4); C. O. Bartlett & Snow Co; Bath Iron Works, Pennsylvania Crusher Div; Bradley Pulverizer Co; Buffalo Hammer Mill Corp; Combustion Engineering, Inc., Raymond Pulverizer Div (Fig. 6); Erie City Iron Works; Foster Wheeler Corp (Fig. 5); Gruendler Crusher & Pulverizer Co; Hewitt-Robins, Inc; Heyl & Patterson, Inc; Jeffrey Mfg Co; Kennedy Van Saun Mfg & Eng Corp; Link Belt Co; Majac, Inc; McNally Pittsburgh Mfg. Co (Fig. 1); Mercer-Robinson Co; Munson Mill Machinery; Patterson Foundry & Machine Co; Pettibone Mulliken Corp; Riley Stoker Corp (Fig. 2); Stephens Adamson Mfg. Co; Sturtevant Mill Co; Strong-Scott Mfg Co; Westinghouse Air Brake Co, LeRoi Div; Whiting Corp (Fig. 3); Williams Patent Crusher Co; Wilmot Engineering Co.

Fig. 1. Power plant of Pensacola Naval Air Station, an example of one of the Navy's outstanding base installations

How the Navy Engineers Its Utilities Conservation Program

To close the inflation dollar gap, the Navy's Bureau of Yards and Docks establishes program designed to save 10% of its $200,000,000 annual bill for utilities operation and maintenance in 270 shore bases. Survey Guide shows DPWO teams how to do it

By J. G. DILLON*

DUE TO a long history of strict conservation of limited utilities aboard ship, the Navy shore bases have always been utilities-conservation minded. Informal programs have been in effect at individual bases for many years. Recently, the Navy's Bureau of Yards and Docks broadened and formalized the approach to conservation with an engineered Utilities Conservation Program, referred to hereafter as UCP. The resultant savings have been both significant and encouraging.

This expanded emphasis on conservation stemmed from economic pressure. For several years, the Navy has been faced with an expanding Shore Establishment without commensurate increase in Maintenance and Operating funds. This, combined with the decreased purchasing power of the dollar, has developed a serious dollar gap. Every possible savings in the use of the funds available was reexplored, with the $200,000,000 annual bill for operation, maintenance and purchase of utilities receiving close study. If 10 per cent of this could be saved, a significant $20,000,000 contribution to the dollar gap could be made.

Extent of UPC

It was to this end that planning for the Utilities Conservation Program was developed in 1955. This planning visualized an organized, engineered program that would be applicable Navy-wide, uniform in approach, yet with sufficient flexibility to account for a wide variety of bases and utilities problems. Early detection of savings that could be immediately realized was to be of prime importance, along with the outlining of problem areas where additional specific engineering studies would yield economies.

There are 270 major Navy shore bases scattered throughout the world, with varying utilities problems, depending upon size, mission of the activity and geographical economics. These bases include industrial types such as large shipyards, aircraft overhaul facilities, ordnance plants; and vary to storage depots, training camps, fleet operating bases and hospitals. While the management of these bases is divided by basic function among the Technical Bureaus of the Navy Department, the Bureau of Yards and Docks is responsible for the technical aspects of utilities at all bases. This involves design and construction of plants and systems, procurement of utilities services and guidance in operations and maintenance. These are the essential elements of a conservation program.

Through its decentralized organization of 17 District (or Area) Public Works Officers, Yards and Docks possesses a means and a technical capability of managing a comprehensive conservation program. These District Public Works Officers now have sent organized survey teams of engineers to visit and survey the operations, management and utilization of major utilities at 150 bases. This represents approximately 55 per cent of those amenable to survey. The estimated immediate annual savings developed thereby approximate $8,400,000; so it thus appears that the goal of $20,000,000 annual savings can be attained once all surveys, plus indicated additional specific engineering studies, are completed.

To fit the program to the widely varying field conditions, it would be necessary to evaluate station utility problems on a sampling basis. Based upon this evaluation would be developed a guide for the conducting of the actual conservation surveys of all activities by the District Public Works Officer (hereafter abbreviated DPWO). This was to be Phase I of three phases.

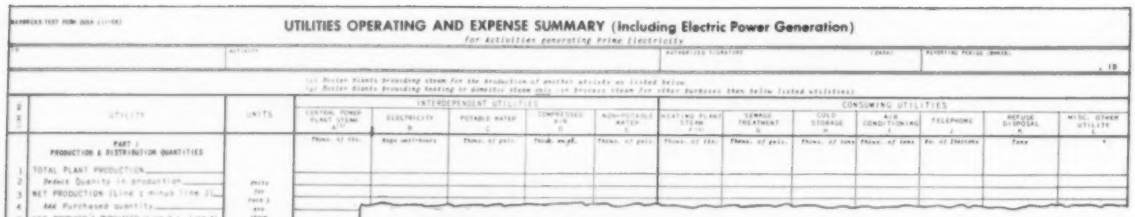
Program Development

As a first step, an engineering firm (abbreviation A/E) was selected to visit representative stations in company with key Bureau and DPWO utilities engineers, survey their overall utilities operations and indicate scope of savings attainable. Ten stations were surveyed in this way. From these findings, it was soon apparent that major economies were attainable and that a pattern for an approach to the problem could be developed that would have the desired flexibility.

From the field evaluation, the BuDocks engineers were able to develop a survey guide for the use of DPWO teams. This guide included basic general instructions in conducting a survey, check-off sheets and format for a simple but direct and complete reporting procedure. It is more completely described below.

Phase II would include DPWO survey team training and the actual conduct of the first complete round of major base surveys, along with appropriate follow-up. Once again, an engineering firm was employed, this time to conduct an actual survey with each DPWO team in accord-

*Commander, CEC, USN; Manager, Power and Utilities Branch, Bureau of Yards and Docks, Department of the Navy



UTILITIES OPERATING AND EXPENSE SUMMARY (Including Electric Power Generation)

For Activities generating Prime Electricity

Fig. 2. NAVDOCKS Test Form 205A. This form effectively prices the cost of utilities

ance with the survey guide. While the DPWO engineers were qualified in their technical fields, training in an organized team approach and in the use of the guide was vital to expediting surveys and early attainment of savings. This step was completed in 1956 and the DPWO teams have subsequently surveyed 138 stations, in addition to the conduct of their normal duties. Some DPWOs have actually completed their first round, while the remainder are scheduled for completion this year.

Setting Norms and Targets

Since team surveys are not planned more frequently than 18 months to two years, continuing follow-up of recommendations in order to attain savings becomes a station and management bureau responsibility. Essential to a continuing conservation program is a means to measure utilities consumption or costs against what might be considered a norm. Two means have been furnished the stations for this purpose. The first are Operating Cost Forms, Nos. 205 and 205A. The former is applicable to activities not generating prime electricity, while the latter has been developed specifically for electric generating stations and is shown as Fig. 2. It is based upon the FPC Uniform System of Accounts, and very effectively prices out the cost of utilities. With these cost reports, the stations can accurately determine if their monthly overall cost trends indicate loss of potential savings. Such reports are essential to proper management of utilities systems.

Second device was the development of Utilities Targets. Literally, a target indicates what would be optimum export steam, fuel, electric or water consumption under a near-perfect operation for a given period of time. For example, in the case of export steam, such a target would correlate degree days, residents (or population equivalent), process steam requirements and heat value of steam to indicate what export quantity should have been for period under consideration. Obviously, the fuel target is the next refinement of the export target and actually can be included by use of a fourth quadrant on the graph.

Fuel targets are normally developed to indicate what fuel consumption should have been if export target were met, and what it should have been based on actual export records. Thus, the value of fuel chargeable to excessive export as well as plant operating inefficiencies is obtainable from the same target graph, Fig. 3.

Of more complexity is the fuel target for industrial power plants generating extraction-condensing power and exporting steam. See Fig. 4 for a typical graph of this kind of target.

In addition to overall targets discussed above, auxiliary targets are set up for pinpointing deficiencies indicated by failure to meet the overall export or fuel target. Such auxiliary targets cover extent of heating, steam utilization by location or category of load, pressure and quality of steam, distribution losses, temperature of returns, flue gas temperature, air fuel ratio, turbine steam rates, and the like.

A graph for the specific determination of throttle and condenser steam targets is shown as Fig. 5.

To compute accurately the utilization and losses for entering on the target graph, either empirical or conventional methods may be used for building heating and line loss calculations. Consumption constants were developed for laundries, and for personnel steam requirements for hot water and cooking under various conditions.

Cost forms and the overall targets have been so designed that the effect of missing an overall target can be priced in terms of unit cost of steam and electricity.

An indirect follow-up feature has been devised with the aim of maintaining a sense of awareness to UCP at working and supervisory level. This is a 14-min movie, which indicates that small savings every day, and the examination of what may have long been taken for granted, can result in appreciable savings on an annual basis.

Program Evaluation

Phase III would include program evaluation, refinement and improvement. Actually, this has been, in part, a continuous process, for all surveys are received and analyzed by Yards and Docks. Early surveys indicated revision and improvements to the guide, and the new guide was issued in early 1957.

In the Bureau review we ask:

Were the recommendations usable?

Have they been put into effect?

Can the DPWO assist in follow-up?

Was the survey conducted with a minimum of station disruption?

Did the station receive new ideas, learn and grow?

Was the survey made on schedule?

In Fiscal 1959, a complete program review will be made before undertaking a second full round of surveys.

Survey Guide

Bone and sinew of the UCP is the survey guide. Briefly, its purpose is to assist the DPWO teams in making surveys of electrical distribution and utilization, steam distribution and utilization, heating plant and power plant operations, utility management, and with potable water and telephone systems on an as-required basis. It contains general instructions on the scheduling of surveys, and on obtaining preliminary data, as well as conducting the survey itself. While it is impracticable to relate in all detail the items covered in the survey,† the following paragraphs indicate the scope of guidance offered.

Electrical Survey

Under the electrical section, the guide calls for: Investigating the procurement contract for possible savings; an engineering analysis of distribution systems to detect deficiencies, which, if corrected, will result in savings; and a survey of utilization facilities and practices to assure optimum saving of power.

To accomplish the foregoing, the electrical engineer team member is given a procedure for analyzing kilowatt demand, timing and cause of peaks, and load scheduling to reduce peaks. Power factor comes in for study as to contract penalties or benefits, and economic effect on operation, even where no penalties exist. Corrective improvements, such as capacitors, are economically analyzed along with proper application of synchronous motor operations.

The engineered analysis of distribution system reviews systems for load factor, diversity, and over-loading with relation to power factor. Voltage and regulation are studied in the interest of reducing losses and improving efficiency. System losses in lines and transformation are checked. In suspected areas, the ratio is established between kilowatts delivered to a system or feeder and kilowatts actually consumed by the equipment.

Excessive transformer capacity is reviewed, because total installed distribution transformation capacity should not exceed 2 to 2½ times peak demand. Distribution transformers should be operated so that peak load approaches full-load rating of units.

As to utilization, study of proper sizing of equipment, selection of voltage rating, and nominal voltage is essential. Outage records are studied to assure that unscheduled outages are restricted to economical minimum. A check-off list of good utilization practices is included.

Preventive maintenance inspections and test practices are reviewed to insure that maintenance and operations are compatible and that maximum efficiencies and minimum major repairs are attained. The adequacy of internal metering, review of charts and records accumulation and use, and the transportation of men and materials complete the outline of the electrical field.

† *Editor's Note:* At present, copies of the Survey Guide are not available for wide public distribution. However, the Bureau will be glad to show the Guide to any engineers interested in adapting its procedures to their own operations. Those interested should communicate with the author of this article.

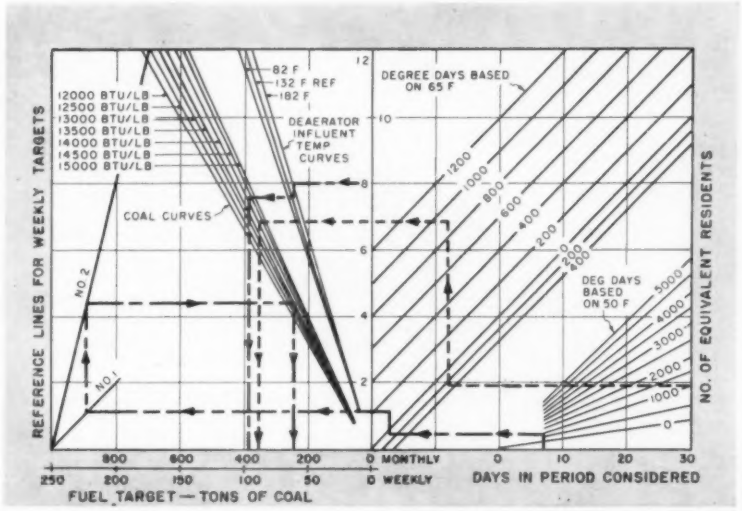


Fig. 3. Central heating plant target graph indicates what the fuel consumption should be if steam export target were met; also value of fuel due to excessive export

Hypothetical Data—line loss 1130 lb/hr, 928,000 Btu 28 day mo. capita, 5 million Btu/deg day/ at 65 deg, 2 million Btu/deg day at 50 deg. Plant efficiency 800 mBtu—55%; 1600 mBtu—60%; 2400 mBtu—63%; 3200 mBtu—66%, 4000 mBtu—68%; 4800 mBtu—70%; 5600 mBtu—72%; 6400 mBtu—74%; 7200 mBtu—& over—76% 125 psig, 132 F av temp condensate return at deaerator inlet.

31-day Month ..... Example: 680 deg days at 65 deg, 200 at 50 deg, 1200 sq res 14,000 Btu/lb coal, 132 deg return
Example: 8,000,000 lb actually exported, 182 deg ret
One Week—.—Example 120 deg days 65 deg; 50 at 50 deg; 1200 equiv residents 14,000 Btu/lb coal, 132 deg return
(m = million Btu)

Targets 6,850,000 lb of steam exported; 356 tons of coal based on heating demand
Target 392 tons of coal based on actual export
Targets 1,170,000 lb steam exported, 61 tons of coal based on heating demand.

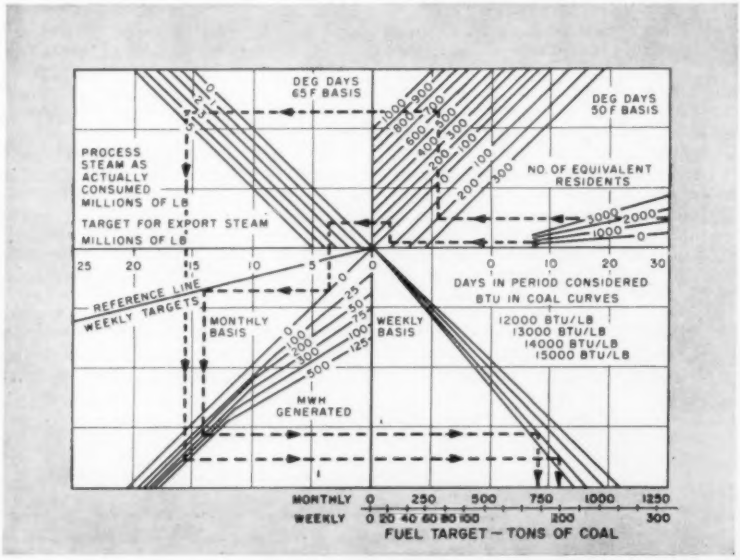


Fig. 4. Export steam and fuel target graph for industrial power plants generating extraction-condensing power and exporting steam. This is typical for the kind

Steam and Power Survey

Similarly, the distribution and utilization of steam is investigated and evaluated. However, in major activities, survey time will not permit a detailed examination of all steam and condensate load connections and systems, so a sampling of about 20 per cent is made. Briefly, the mechanical engineer will check the system for delivery of dry steam of correct pressure and temperature; check return line temperatures for indication of faulty trap operations; check undue

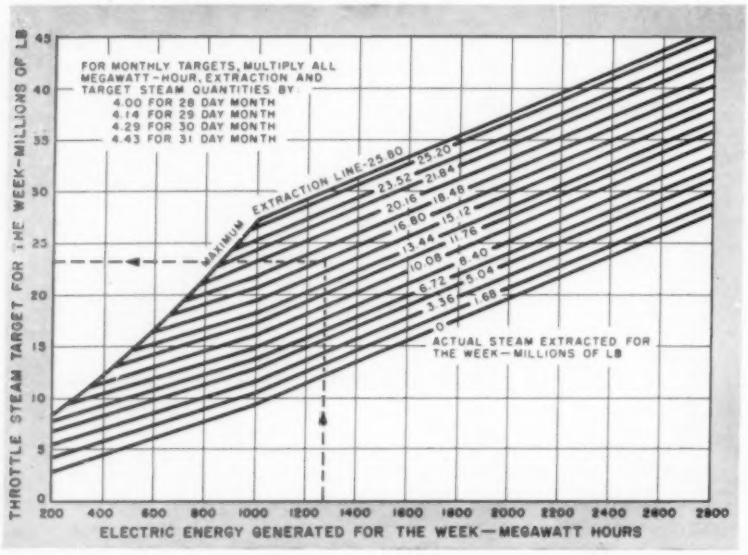


Fig. 5. Target graph for determination of turbine throttle and condenser steam

Plant shown consists of 1–5000-kw, 850-psi, 825-FTT, 160-psig auto-extraction unit & 2–5000-kw 600-psi, 750-FTT condensing units, all capable of continuous operation at 6000 kw each
Illustration: 1,250,000 kwh generated, 16,800,000 lb of steam actually extracted. Throttle steam target = 23,000,000 lb of steam. Condenser steam target = (23,000,000 – 16,000,000) = 6,2000,000 lb of steam.

wastage; spot check various valves for proper seating, gland leakage and freedom of movement; inspect cleanliness of strainers, condition of PRVs and expansion joints; check the general condition of manholes with respect to flooding and leakage; and check the condition of steam piping with respect to insulation, weatherproof coverings, corrosion, leaks and losses.

On use of steam, non-heating season operations are reviewed for economies in reduction of line pressures and distribution routes and practicability of removing some loads from the system and substituting individual-fired equipment during the non-heating season. Buildings are checked for proper temperatures and temperature control equipment.

Physical condition and cleanliness of heat transfer surfaces of heating equipment is checked. A review is made of general heating practices, such as excessive opening of windows, heating of unoccupied spaces, vestibule temperatures, use of large opening doors, over-heating of hot water and excessive consumption. The Maintenance Program and the effective use of personnel as watchstanders is investigated.

One major area of savings lies in the actual operations of heating and power plants, and the guide is very detailed in this respect. Typical of items surveyed are fuel selection, fuel handling, feedwater treatment, boiler and boiler auxiliary operation, as well as maintenance of the plant equipment. All aspects of fuel firing are considered and include adjustment of oil burners, temperature of fuel, relationship of fuel flow to atomizing steam, condition of stokers, grates and pulverizers. Particular attention is given to lighting of burners and stokers, bringing up steam, maintenance of water level, soot blower schedule, air heater operations, loading of boilers under varying conditions, proper measurement of fuel, water, steam, CO_2, pressure, temperatures, and delivery of steam of proper quality.

Plant water conditioning is a key to efficient boiler operations and this aspect is studied to insure that total dissolved solids, suspended solids, alkalinity, phosphate, sulphite residual and other treatment is being done properly. Deaerating feed heaters are checked for proper feed temperature, mixing of steam and water and venting. Boiler plant auxiliaries and controls are reviewed for their proper use. Electric generating facilities receive considerable attention as to scheduling for maximum economy and loading as related to export steam loads and power purchase rates. Methods of bringing a machine up to speed, loading and unloading are reviewed.

Complete series of overall and auxiliary targets is prepared and checked against one-week operation.

Utility Manager portion of the survey is to review the overall utilities operations. This includes cost accounting, general organization, spares control and staffing. Instruction is given in the use of targets and the general *continued on page 115*

V. BOILER PLANT WATER TREATMENT – Plant No. _____ Bldg. No. _____ Boiler No. _____

A. Is proper external feed water treating equipment installed for type and size boilers? ☐ YES ☐ NO

Investigate and check off: Softeners, demineralizers or evaporators _____

Capacity and type of equipment _____

B. Is proper internal feed water treatment being accomplished? ☐ YES ☐ NO

C. State amount and kind of chemicals fed to boilers _____

D. Is proper testing equipment available? ☐ YES ☐ NO Being used? ☐ YES ☐ NO

E. Are proper boiler and feed water conditions being maintained? *(Give boiler capacity, working steam pressure and application).* ☐ YES ☐ NO

Test for *(Indicate results of test and whether satisfactory (SAT) or unsatisfactory (UN)).*

CHEMICAL AND DESIRED RANGE Total dissolved solids

Fig. 6. Typical test form from Survey Guide carefully covers the many details of equipment and operation that are under study

Looking ahead . . .

How About Rocket Fuels for Gas Turbines?

ENERGY RELEASE rate in the combustion chamber of a rocket may exceed 20 million Btu per cu ft per hr at present. This rate is approximately five times the corresponding rate for combustion in a gas turbine and about 300 times the rate for a conventional boiler.

Temperature of combustion in a rocket can be as high as 8500 F. Cooling of the container walls against an 8500 F flame is a colossal engineering feat, when it is recalled that the temperature of the sun's surface is only 12,000 F, not too much higher than the rocket's 8500 F.

Heat transfer rates of 1 to 20 Btu per sq in per sec through the walls of the rocket represent ten times the rate through a conventional heat exchanger.

The full measure of power is realized when one watches the exhaust gases stream out of the nozzle. To develop the required thrust the long-range rocket must expel more than half a ton of propellants each second at a velocity of 8000 fps (5450 mph).

Thus it is understandable that the energy sources available from rocket propellants have permitted rockets to achieve 18,000 mph and that the escape velocity of 25,000 mph may be achieved before the end of 1958.

Question which naturally comes to the fore in all this is: Can this exotic source of power be harnessed for industrial use?

One possible application of high energy propellants to industrial power is found in the rocket motor turbine, as explained by C. C. Miesse and P. Lieberman, both of Armour Research Foundation, in a paper presented before the 1958 American Power Conference by Mr. Miesse, and from which these data are taken.

The figure indicates a possible rocket motor turbine cycle. The p-v diagram illustrates the thermodynamic work which can be realized from such a cycle.

Step ab represents constant pressure heat addition or combustion process, and bc adiabatic expansion process. Heat rejection of the cycle is carried out at constant pressure cd. The liquid propellants are pumped at essentially constant volume from pressure P_1 to P_2. Net work of the cycle is represented by abcd. If the reactants were air and fuel, the compression work becomes sizable as represented by dotted line d'a. Thus the elimination of the compression work results in a greater net work for the rocket turbine cycle as represented by the area add'.

Inherent drawback of the indicated cycle is the high temperatures to which the materials are subjected, especially the combustion chamber and the turbine bladings. Since the turbine bladings are subjected to dynamic stresses as well, provision for cooling the gases by injection of a coolant into the high velocity jet stream is shown schematically in the figure.

Ultimate success of such a proposed cycle would of course depend on the harnessing of the high velocity jet in the impulse-type gas turbine. The exhaust heat can be utilized to preheat the injection water for maximum plant efficiency.

Advantages of the illustrated cycle are numerous. Most important of all, the elimination of the enormous compressor work in the conventional gas turbine cycle results in a smaller-sized turbine for the same net horsepower output. This can be readily appreciated by the fact that

$$W_{net} = W_{turbine} - W_{compressor}$$

Usually in conventional gas turbine cycle, the turbine work must be 5 to 10 times greater than the net cycle work.

In the absence of the need for a compressor, the following features are immediately apparent:

1. Smaller-sized turbine for equal output results in saving of initial plant investment, compactness, lightness;

2. Possibility of a power plant in the low horsepower range which is not possible by the conventional gas turbine because of the limitations of existing compressor and turbine efficiencies;

3. Heat addition at the higher temperature level results in a more efficient thermodynamic cycle.

Relative advantages of a rocket motor turbine using gasoline and liquid oxygen, at 500-psi chamber pressure, and a gas turbine using gasoline and air, are summarized by the following table:

	Rocket Motor Turbine	Gas Turbine
Change in enthalpy, $H_{isentropic}$	1440 Btu/lb	176 Btu/lb
Change in enthalpy, H_{net}	1150 Btu/lb	49.0 Btu/lb
Total propellant per lb of fuel	3.28 lb	69.5 lb
Turbine inlet temperature	5770 F	1450 F
Ideal thermal efficiency	25.5%	38.1%
Actual thermal efficiency	20.4%	18.1%

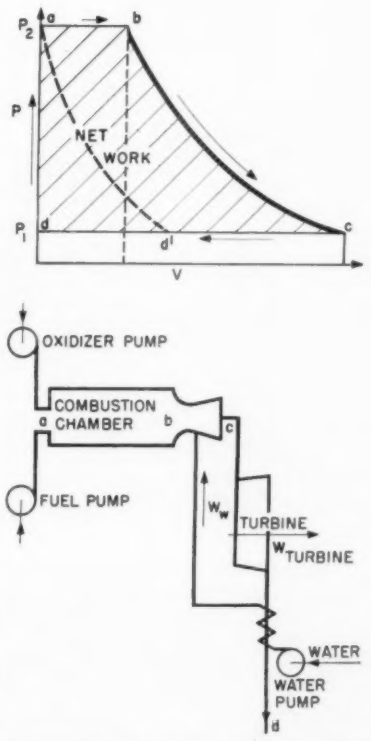
It is noted that the net work for the rocket turbine is equal to the actual turbine work, while for the gas turbine, the turbine work must be reduced by the work of compression.

Although the available energy of the rocket propellants exceeds that of the conventional propellants by a factor of 29, it is apparent that the decrease in total flow results in comparable efficiencies at combustion temperatures. However, since the combustion temperature of the rocket propellants exceeds the maximum allowable temperatures of the turbine components by some 4000 F, cooling of the combustion gases prior to the turbine inlet is necessary.

Unfortunately, the heat lost in achieving acceptable temperatures far outweighs the gain incurred by additional mass and work of vaporized coolant, so that, for the case of water injection, the over-all efficiency of the rocket turbine is reduced to 9.1 per cent.

Obviously, further developments in the fields of turbine materials and/or more efficient use of the rocket motor's glowing power will be necessary before the rocket motor turbine becomes an industrial reality.

But the power is available. The system is simple. And its effective utilization is ultimately dependent only on man's ingenuity. THE END



Possible rocket motor turbine cycle. P-V diagram (top) illustrates thermodynamic work realized from this cycle

POWER ENGINEERING'S

1 Heightening the stacks of Elrama Power Station (right) of Duquesne Light Co by 60 ft has been done with welded steel plate sections 8 ft high, 15 ft long, ¼-in. thick. 1350-lb sections were made by McAleenan Brothers Co

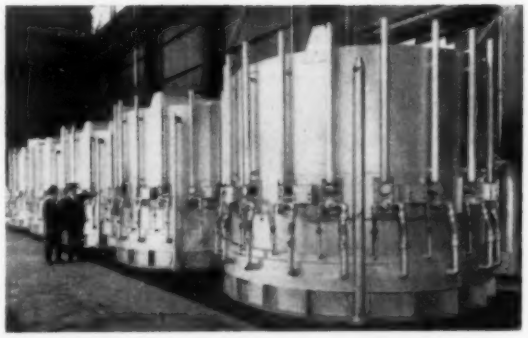
1

2 Elrama (Penna.) Station's stacks had to be extended to clear the top of a building planned for location adjacent to the power plant. This view shows two stacks completed. With extensions, stacks tower 272 ft above ground

2

3 Nuclear fuel pellets—each about the size of the filter tip of a cigarette—are being made from uranium powder at Westinghouse plant at Blairsville, Penna. Pellets are punched out on press, heat treated, inserted into stainless steel tubes to become part of reactor fuel element

4 Heat of 1650 F can be produced by each of these five new spheroidizing (annealing) bell-type furnaces at Waukegan, Ill., plant of U. S. Steel's American Steel and Wire. Huge crane lifts each furnace, still hot, high in air, moves it down and over base loaded with wire coils



4

5 59-ton stator of a 19,200-kw hydroelectric generator under construction at a Westinghouse plant in California. Electrical coils are being installed around inner ring. Directly behind the stator is a similar unit in earlier stage

6 Pelton Dam project of the Portland (Oregon) General Electric Co, on the Deschutes River, has nearly doubled the company's hydroelectric power generating capacity. Pelton now has capacity of 108,000 kw. Three G-E generators are located in outdoor station by concrete arch dam

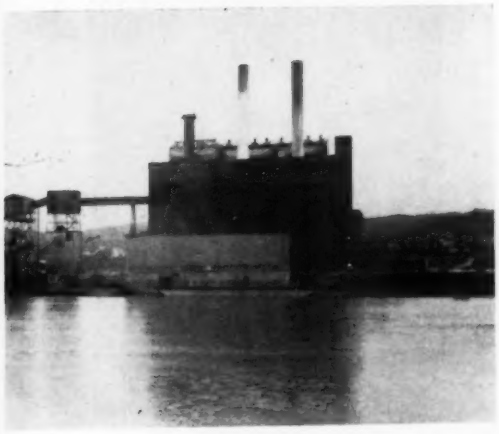
7 Miniature gas turbine weighs only 30 lb, will deliver either 5 or 10 hp. Made by Propulsion Research Corp, it's called Turbo-Mite, is designed to operate at temperatures from minus 65 F to plus 165, in almost any climate

7

8 Inside the steam drum of the huge boiler for the new 305,000-kw turbine generator now being installed at Commonwealth Edison Co's generating station in Waukegan, Ill. Drum is 72 ft long inside, 88 ft outside, weighs 150 tons. Commonwealth Edison has three such units now going in

9 Push-button pouring at the nation's second largest aluminum plant—Ormet Corp's facility near Hannibal, Ohio. Here a crane operator controls pouring of aluminum into 1000-lb pig molds from a 7000-lb capacity crucible. Ormet has annual capacity of 180,000 tons of aluminum

NEWS REEL



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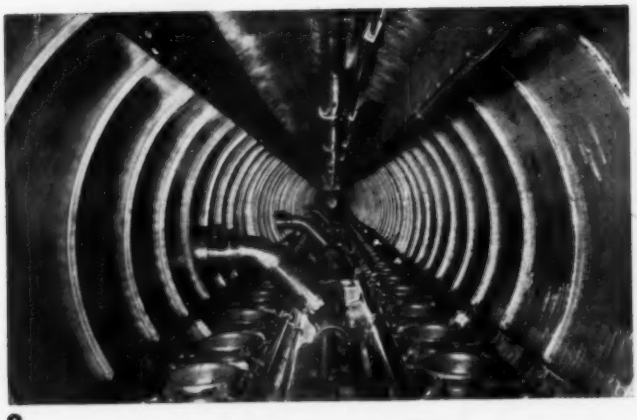

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9

To Clean Your Condenser— Backwash Is Cheapest!

Requiring little or no reduction in load, this method of cleaning steam surface condensers reduces labor to a virtually negligible amount, and can be installed on old or new condensers. Here's how!

By THOMAS E. HITZEMAN * and H. W. FEIST *

WITH EVER-INCREASING demand for power, many plants are forced to extend the load on their generating equipment to the utmost. The problem of shutdown for maintenance has become extremely critical. Even short intervals of downtime often result in the loss of a great deal of money.

Steam surface condensers are a vital but sometimes overlooked link in the operation of a power plant. Many times turbine performance is given first attention while continued trouble-free and efficient condenser operation is taken for granted.

Frequently the debris brought in with the condenser circulating water results in matting or plugging of the condenser tubes. This undesirable situation may develop to a point where the unit must be removed from the line. Since a condenser is such an essential part of a steam power installation, its failure results in a forced shutdown of the entire system.

Use of a backwash system provides an easy and economical method of helping to maintain cleanliness, while allowing continuous operation of the unit, thus improving vacuum in the condenser, allowing the steam turbine to operate more efficiently. The savings gained in the reduction of downtime plus the flexibility of application warrant serious consideration of backwash systems.

Need for Backwash

A steam surface condenser is basically a heat transfer machine. The action of a condenser amounts to a continuous abstraction of heat from a volume of steam within a closed vessel which results in condensation of the steam with a corresponding drop in pressure. The greater the rate of heat transfer between the steam and the circulating water through the tube wall, the better the vacuum and efficiency of the condenser.

Similarly, the vacuum is dependent upon the temperature and quantity of the circulating water flowing through the tubes.

Rate of heat transfer referred to in condenser calculations is based upon commercially clean tubes. In actual operation the tubes cannot be maintained at this standard of cleanliness. Consequently, as tubes become dirty the rate of heat transfer is reduced and likewise vacuum is decreased.

Normally a per cent tube cleanliness, which can reasonably be maintained, is either known or can be assumed. Although cleanliness is entirely dependent on the cooling water characteristics, normal practice bases performance guarantees on a value of 85 per cent of that obtainable with clean tubes.

Decreased Efficiency

Often condensers that were designed for normal or estimated water conditions may have to operate with very poor water, that is, the circulating or cooling water is drawn from a dirty river or lake. Debris of all kinds may be drawn into the condenser with the large amounts of circulating water. Leaves, twigs, hair, fish and some plant forms are but a few examples of this foreign material. Even the use of screens does not entirely eliminate the presence of this debris.

Constant inrush of water draws and wedges this material against the tube ends and tube sheets in the water box of the condenser. In a short time thick layers of this material may be built up, resulting in some tubes becoming partially or completely plugged. As the number of tubes that are plugged increases, the amount of water being circulated through the tubes is reduced.

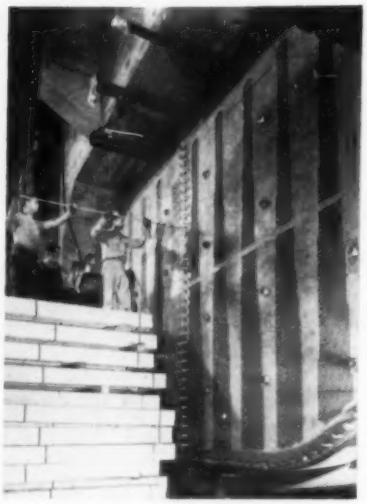


Fig. 1. Tubing a large divided-water-box surface condenser. Note studs which will support vertical dividing wall

Since the vacuum depends upon the inlet temperature of the cooling water and the quantity of cooling water passing through the condenser, the plugging of condenser tubes presents a serious problem. The reduction in water flow reduces the heat transfer rate through the tube walls and consequently decreases the vacuum.

Plant location and environment sometimes leaves no alternative but to draw cooling water from poor sources. Seasonal changes bring storms, floods and other weather conditions which produce much debris and foreign matter in the water supply. Even under normal conditions a certain amount of general cleaning is required. So every condenser user is afflicted sometime or other with the problem of plugging.

Fouling of tubes has always been a problem with condensers. The fre-

* Allis-Chalmers Mfg Co

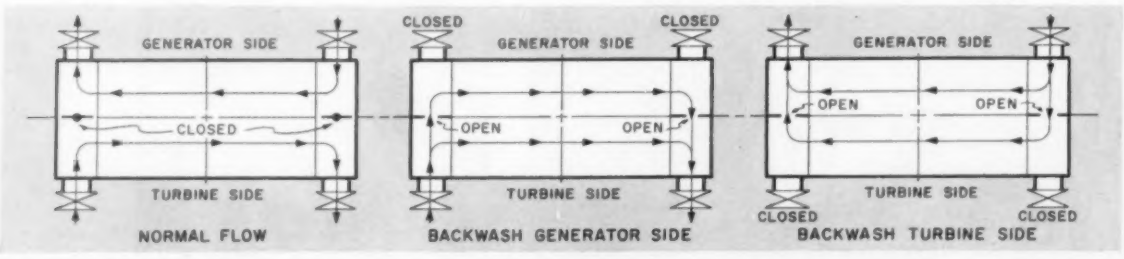


Fig. 2. Plan views show method of backwashing a single-pass condenser. System necessitates slight if any load reduction

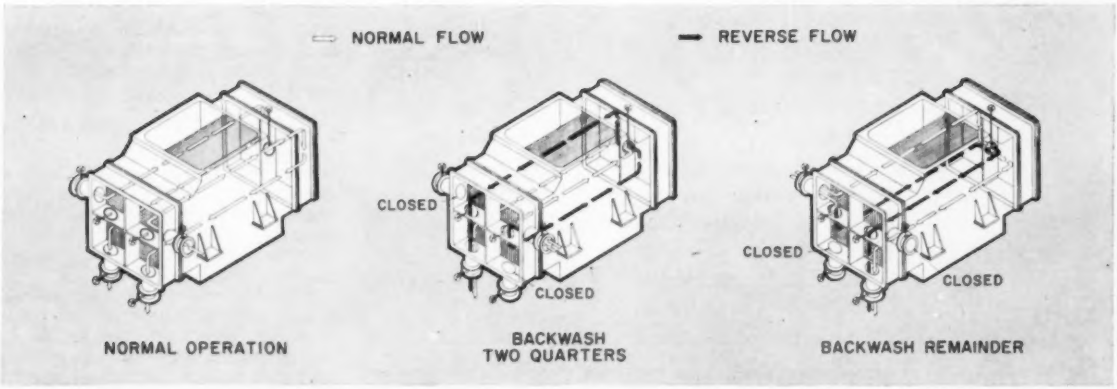


Fig. 3. Backwash system for a two-pass divided-water-box condenser. With valves inside, this is known as an internal system

quency of shutdowns for cleaning motivated condenser manufacturers to search for some method of clearing the debris from the tube ends while still operating the condenser.

As early as 1924, variations in condenser design were being employed to try to find a solution to easy condenser cleaning. Partitioned water boxes, hinged doors, manholes and other alterations in the water boxes were some of the innovations used to give access to the tube sheets and tube ends so they might be cleaned.

Even with accessibility to the tubes, the unit had to be removed from the line and shutdown or at best forced to operate at a small percentage of full load. Time, manpower and loss of generating potential added up to a costly total for cleaning.

Over a period of years backwash systems have been developed which eliminate down-time, reduce manpower to a minimum, and restore generating potential to the system.

Operation and Application

Backwashing is reversing the normal direction of flow of the circulating water through the condenser tubes. This reversal of water flow provides the cleaning action by washing the debris from the tube ends and out the water box. Various butterfly valves, both internal and external to the water box, are employed to reverse the flow of water while the condenser is operating at or near normal steam load.

After sufficient time the valves may be so regulated as to return the flow of water to its proper direction, thereby completing the cycle of cleaning. The entire operation is accomplished without shutdown.

Backwash systems are quite flexible in application. This may best be illustrated by examples of representative condensers of various types and arrangements.

A good example of backwashing is found in a one-pass condenser with divided water box, such as shown in Fig. 2. This particular system is called an *internal* backwash system because the valves used for directing the flow of water are located within the condenser itself. The unit has a vertical partition in the water box dividing it into two chambers

In Fig. 2, the rectangular sections at both ends of the unit are the water boxes, the separation in the water boxes being the metal partition in which a butterfly type of valve is mounted. Individual tubes are not shown for simplicity but it should be understood that the area between the water boxes contains the tubes.

Normal flow is such that water enters from opposite ends, flows through the condenser in the separate channels formed by the divided water box and finally discharges at opposite ends.

Versatility of this application is shown by backwashing a particular section, or as in the center sketch, the generator side of the condenser. The cross-hatched area represents the side being backwashed. The inlet and outlet valves on this side are closed, and the valves in both water box partitions are open.

Flow of water in the plain section or the section not being backwashed continues in its original direction, but because of the open valves in the water box partition, the water flows into the adjacent channel opposite to its original direction. This section of the condenser is now being backwashed.

To backwash the remaining side of the condenser, the inlet and outlet valves of that side are closed (after opening their counterparts on the generator side), while leaving the internal valves open. In this manner we have reversed the direction of water flow in both sides, one side at a time, thereby backwashing the entire condenser. This unit has added versatility in that it can be operated as both single and two pass.

Two-Pass Condenser

Backwashing may also easily be used on a two-pass, divided water box condenser. In a two-pass condenser, the water flows the length of the condenser twice. Figure 3 shows the normal flow arrangement of such a unit. The inlet water box is divided into four sections or quadrants, whereas the rear water box is divided vertically into two sections. The inlet water box partition has two internal butterfly valves while the rear water box partition has only one.

During normal flow, the water enters the inlet water box from both sides through the main inlet valves, flows the entire length of the condenser to the rear water box where it is forced down, turned and channeled back through the entire length to the front and out the bottom two outlet valves. All internal valves are closed under normal flow conditions.

For convenience in describing directions of flow and sections of the condenser, the four quadrants of the inlet water box are called nearside upper and lower, and farside upper and lower. In this way the backwashing arrangement will be more easily followed.

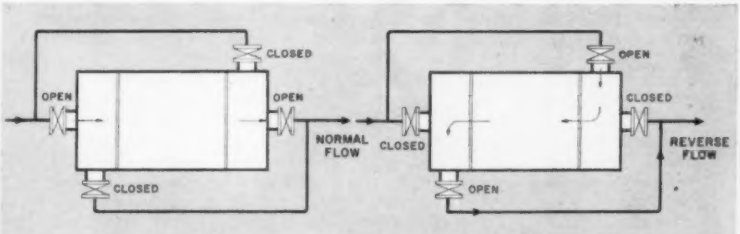


Fig. 4. Sketch of external backwash system for use with a single-pass condenser

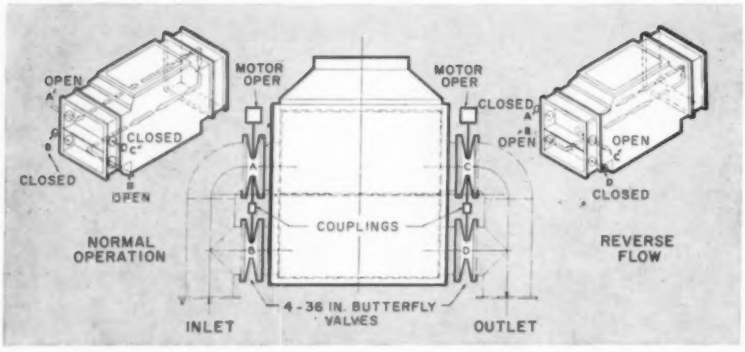


Fig. 5. Application of external backwash to a two-pass, divided-water-box unit

To backwash the upper farside and lower nearside, the farside inlet and nearside outlet valves are closed while all internal valves are open. The water is directed through the nearside inlet valve. Finding the internal valve open the water passes down through the opening and is directed through the condenser toward the rear. In effect, water is flowing through one-half of the condenser by means of the two channels. The flow in the lower nearside channel is opposite to its original direction, therefore backwashing this particular channel.

In the rear water box, the water is forced through the open valve and turned frontward to pass through the remaining two channels. Again, the flow in the upper farside channel is opposite to its original direction, thereby providing backwash action. Upon reaching the front, the water is discharged through the farside outlet.

To backwash the rest of the condenser, a similar sequence of events occurs. The nearside inlet and farside outlet valves are closed, again all internal valves are open. The upper nearside and lower farside are backwashed in the same manner as previously described.

External Valves

In contrast to internal systems, there is also what is known as an *external* backwash system. With the external system all valves and piping necessary for channeling the water in the desired direction are outside or external to the condenser. Figure 4 shows a single-pass condenser with such an external backwash arrangement. Normal flow of water is through the inlet valve at the front. The water makes a single pass through the unit and is discharged through the outlet valve at the rear.

Reverse flow or backwashing of such a unit is pictured where, because of the closed inlet valve, the water is shunted to the rear water box. For simplicity, piping is represented by single lines with arrows indicating direction of water flow. Here the water is directed into the unit through a side valve where it flows toward the front in opposition to the normal direction of water flow. The water is then discharged from the front water box. This is a very simple and effective backwash system.

Applying an external backwash system to a two-pass condenser is equally as easy as the single-pass unit. Notice in Fig. 5 that this arrangement uses four external valves, two on either side of the front water box, to channel the flow of water. Observing the valve openings and their letter designations, we can follow the normal direction of flow.

Water enters valve A in the upper section, flows through the condenser to the rear water box where the water flows down into the lower section and is turned back through the unit toward the front. The water reaches the front water box and is discharged through valve D.

Reverse flow operation finds valves A and D now closed and valves B and C open. The water enters the lower section of the unit through valve B, passes through the condenser, turned around in the rear water box and sent back through the upper section to the front where it is discharged through valve C.

Installation on Existing Units

There may be occasions where condensers have been installed for various lengths of time, and, due to unforeseen changes in the water conditions or other operating circumstances, it becomes necessary to adopt backwashing.

Figure 6 gives an example of such a unit built originally without backwashing. This was a single-pass condenser with a non-divided water box and two valves located at the inlet end with one connection at the outlet end. It was decided to place two additional valves in the inlet water box, to partition the water box and to place a damper in the discharge pipe.

Right-hand figure shows how the unit can now be backwashed one side at a time. Observing which valves are open and closed, the water enters through the side of the inlet water box, passes through the condenser to the rear where some of the water passes the damper in the outlet line and is discharged. Depending upon the damper setting, most of the water is turned frontward again and passes through the cross-hatched area or section being backwashed. The water is then discharged into the external pipes through the front valve.

To backwash the other side of the unit, the reverse operation is performed, closing the necessary side and front valves.

Flexibility in applying backwash systems saved this condenser installation from long hours of forced down time. The savings gained in labor costs for cleaning will alone pay for the adaptation of backwashing.

These are by no means the only types of backwash systems. Those illustrated all use butterfly valves, but other types are many times used. Butterfly valves are popular because they have low friction losses.

Motor-Operated Valves

Valves can be controlled either at the condenser or from some remote location. In some instances where backwashing is required frequently, a time sequence control can be installed so as to automatically open and close the necessary valves at the proper time intervals and thereby backwash the condenser. Backwashing may be scheduled at predetermined light load periods so there is never any interruption in installation performance.

Forced down-time on generating units is expensive to a utility. This expense may be out of the pocket, but it can also be in loss of customer good will. The necessity and reliability of backwashing have been proven, and backwashing systems of steam surface condensers have gained in importance where continuous operation is essential. THE END

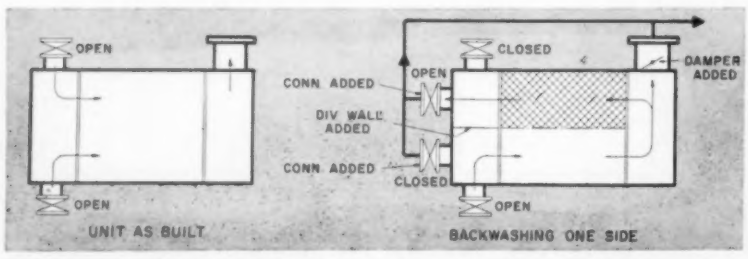


Fig. 6. Two sketches showing how backwash is applied to an existing condenser

Power Engineers' Valve Manual . . . .

This third article, in a series on valves commonly used in the power field, is on Blow-Off valves. Preceding articles — by experts — covered Plug and Check valves. When completed, the series will be reprinted as a Valve Manual for power engineers in all fields and industries

BLOW-OFF VALVES

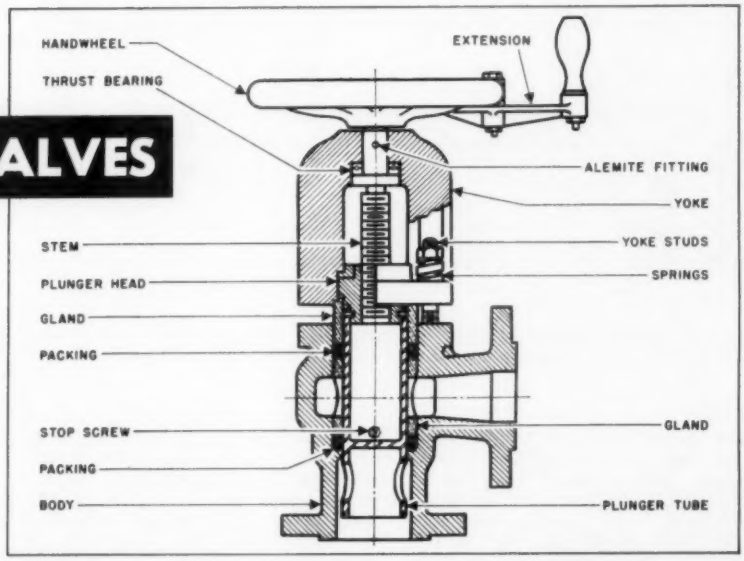
By EDWARD E. FINSEL

Section Leader,

Valve Engineering,

Yarnall-Waring Co

Edward E. Finsel, a native Philadelphian, graduated from Drexel Institute of Technology in 1944, as a mechanical engineer. He served in both the U. S. Army Air Corps and Signal Corps. After a four-year association with American Engineering Company, of Philadelphia, Penna., and a four-year period with The U. S. Navy Department in naval inspection, he became associated with Yarnall-Waring Co. in their Valve Section. His duties there involved the design and application of valves, principally in the power field. During his ten-year association with this company, he has advanced to Engineering Section Leader in charge of valves, which position he currently holds. His leadership and integrity, plus his fully-rounded diversified experience, make him a highly valuable designer and consultant in the valve field.



BOILER BLOW-OFF VALVES are generally used as prescribed by the ASME Power Boiler Code, Section I. The code indicates the basic requirements as well as specific limitations; and generally blow-off valves are designed, selected and applied in accordance with these requirements. The code states:

A. Each boiler shall have a bottom blow-off pipe fitted with a valve or cock in direct connection with the lowest water space practicable.

B. The minimum size of pipe and fittings shall be 1 in. and the maximum size shall be 2½ in. except that for boilers with 100 sq ft of heating surface or less, the minimum size of pipe and fittings may be ¾ in.

C. Straight-run globe valves of the ordinary type, or valves of such type that dams or pockets can exist for the collection of sediment, shall not be used on such connections.

D. Straightway Y-type globe valves, or angle valves, may be used in vertical pipes, or they may be used in horizontal runs of piping, provided they are so constructed or installed that the lowest edge of the opening through the seat shall be at least 25 per cent of the inside diameter below the centerline of the valve.

E. Return connections of the same size or larger than herein specified may be used, and the blow-off may be connected to them. In such case the blow-off must be so located that the connection may be completely drained. All water walls and water screens which do not drain back into the boiler and all integral economizers shall be equipped with drains or blow-off valves conforming to this paragraph (P-308), and paragraphs P-309 and P-311.

From the above it can readily be seen that blow-off valves are somewhat different in design and application than ordinary globe or gate valves. Blow-off valves are usually designed and applied in accordance with these requirements and the requirements of paragraphs 299, 309, 310 and 311, of the code.

Purpose of Blow-Off Valves

Since blow-off valves are installed at low points of the boiler water system, it is obvious that one of their principal uses is to help remove suspended solids or impurities, particularly those that tend toward sedimentation. Secondarily then, it is also obvious that in blowing down, a portion of the boiler water is discharged thereby reducing the water-level in the boiler. This function therefore aids as a safety measure, in avoiding carryover of water from the

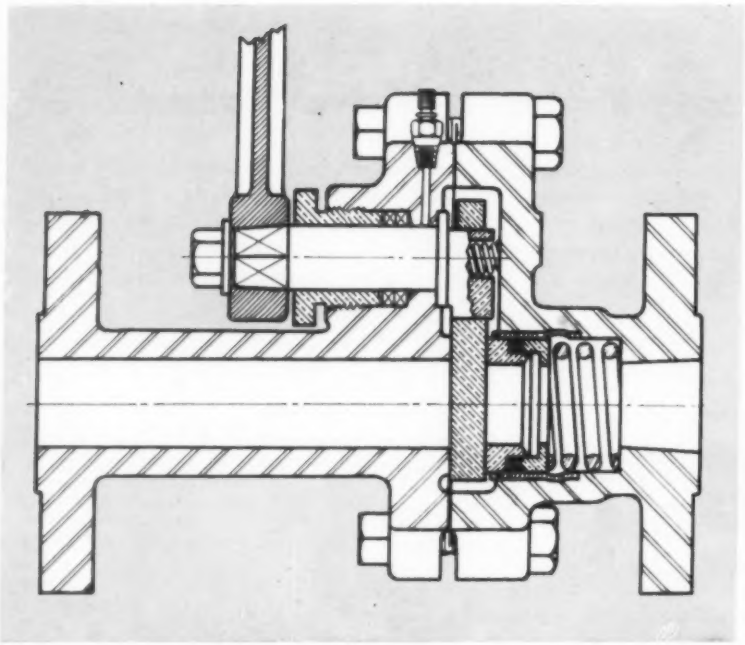


Fig. 1. Illustration of quick-acting, lever-operated valve; made in direct and gear-type design; is placed nearest boiler when used in tandem with seatless valve

main steam drum in the event of high boiler water-level for whatever reason. A third use of these valves, but far less frequent, is the introduction of boiler cleaning acid to the boiler, and again draining of this acid after the boiler is acid-washed. Many boiler operators choose to pump this fluid through the blow-off valves, since they usually are a handy means of ready access to the boiler.

Pressure Ratings Set By Code

The power boiler code also fixes the pressure ratings for blow-off valves. To properly apply blow-off valves one should be familiar with the code requirement for this service.

Paragraph P-310 of the code covers valve pressure ratings. Carbon steel fittings and valves designed to American Standards Association (ASA) requirements for 150, 300, 400, 600, 900, 1500 or 2500 psi are limited by the code under this paragraph, in that they may be used for blow-off line service, provided their adjusted pressure-temperature ratings exceed the maximum allowable working pressure of the boiler by 25 per cent, or 225 psi, whichever is less.

To avoid the need for calculations, the Boiler Code Committee has set up a table listing adjusted pressure ratings for saturated steam-temperature conditions, and the allowable values in blow-off service. For convenience, this is shown in Table I.

An accurate graphical method for determining the reduced value for blow-off service is also available. In it the pressure-temperature curve for saturated steam is plotted along with the pressure-temperature curve for a Class "A" steel, 1500 lb fitting as used in steam service. Another curve is plotted, 225 psi below the valve curve; where this lower curve intersects the steam curve, the blow-off rating is fixed. As graph shows, ASA 1500 psi carbon steel valves have a primary temperature rating of 850 F. They may be used to 2500 psi for saturated-steam service, and to 2325 psi for blow-off service.

To save time, valve selection tables usually list the ASA primary pressure rating, such as 1500 psi, and the ASME code pressure for blow-off, such as 2325 psi. Saturated steam rating, in this case 2500 psi, is not ordinarily listed. Table II is a typical example of condensed data on tandem carbon steel blow-off valves.

Blow-off valves of cast-iron construction are also permitted for boiler blow-off service. Their rating in this service is limited to 80 per cent of the nominal ASA fitting rating. For instance, a 125 psi fitting is limited to 100 psi blow-off service, and a 250 psi fitting is limited to 200 psi blow-off service. Brass or bronze valves may be used, provided they are at least equal to the strength requirements of the American Standard cast-iron fitting which would otherwise be required. Steel blow-off valves are required for boiler pressures over 200 psi. If boiler pressure is over 100 psi and iron blow-off valves are to be employed, they must be equal at least to the requirements of American Standards for 250 psi.

Blow-off valves may be connected as screwed, flanged or welded fittings.

Blow-Off Valve Types

There are many different types of blow-off valves manufactured. These could be classified as follows:

1. Seatless, sliding-plunger type.
2. Sliding disc, or non-wedging gate type.

Table I. Maximum allowable boiler pressures for use with American standard steel pipe and flanges, fittings and valves

		Maximum Allowable Pressure	
Primary Pressure	Type of Flange	Steam Service	Blow-off Service
150	Class A	190	160
	Class B	180	150
300	Class A	630	515
	Class B	510	415
400	Class A	820	665
	Class B	665	540
600	Class A	1160	970
	Class B	960	785
900	Class A	1640	1450
	Class B	1360	1170
1500	Class A	2500	2325
	Class B	2100	1910
2500	Class A	3206	3206
	Class B	3150	2975

Table II. Tandem blow-off valve selector table. (Carbon steel bodies) Listed are unit tandems and two valves in tandem

			Tandem Combinations Available			
			Unit Tandems		Two Valves in Tandem	
Basic Pressure Ratings, psi	Maximum allowable boiler pressure	Valve Connections	Hard-seat-Seat-less	Hard-seat-Hard-seat	Hard-seat-Seat-less	Hard-seat-Hard-seat
600	970 psi	Class A Flanged or Welding	X		X	
1500	1850 psi	Class A Flanged or Welding	X		X	
1500	2325 psi	Class A Flanged or Welding		X		X
2500	3206 psi	Class A Flanged or Welding		X		X

3. Seat and disc, or hard seat type.
4. Combination of two of the above valves in a common body.

Since the boiler code indicates that on boilers where the pressure exceeds 100 psi, each bottom blow-off pipe should have two slow-opening valves, or one slow-opening and one quick-opening valve, both types are offered by manufacturers. By definition a "slow-opening valve" is one which requires at least five 360-degree turns of the operating mechanism to change from full-closed to full-open, and vice versa. In the above listing it can readily be seen that without gear operation, the sliding-disc type is generally a quick opening valve.

The seatless valve, as shown at beginning of article, is classified as a slow-opening valve. It has a rotating non-rising stem, which when turned withdraws the plunger so that its ports coincide with the body inlet port. Blow-down flow then is through the lower portion of the plunger and out through the discharge end. This valve is furnished in both the angle, and straightway pattern.

In the sliding-disc type of valve, which is not shown, the disc seals the opening through the valve when in the closed position. This disc has a through hole on one side, which is swung in line with the bore of the valve, and through which flow takes place when the valve is open. This is known as a quick-opening valve, and is furnished in a straight-through pattern only. It must always be used in conjunction with a slow-opening valve, for blow-off service.

Another style is a seat and disc type of valve which is normally employed on higher pressure boilers. It has a rising, rotating stem, at the bottom of which is attached a disc. This disc is free to rotate, and mates with the valve seat in the body. Both disc and body seat have hard-faced seating surfaces. This valve is also classified as a slow-opening valve.

Since the boiler code permits the use of two blow-off valves in a common body, some manufacturers take advantage of this fact. This arrangement eliminates another bolted, or welded, connection between the valves, and provides a relatively compact unit to be used at each blow-off location. An example of this is the combination shown in Fig. 2. This shows a seat-and-disc type of valve used as the blowing-valve installed next to the boiler, and a secondary seatless valve used as the sealing-valve. Between these two valves there is an opening in the body to allow through-flow.

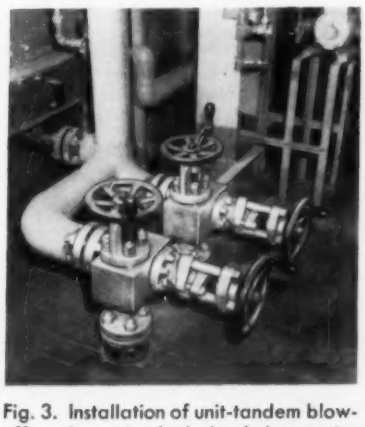


Fig. 3. Installation of unit-tandem blow-off valves, in Lederle Laboratories

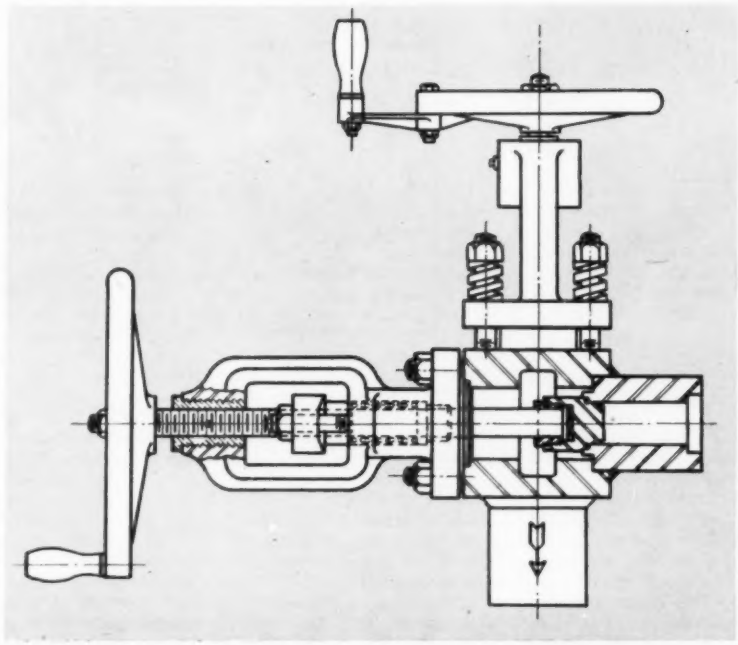


Fig. 2. Unit-tandem valve, which contains both hard-seat and seatless valves, in open position. The style shown is designed specifically for flanged connections

As previously mentioned, blow-off valves are frequently used for the introduction and drainage of boiler-cleaning acids. This is severe service and manufacturers select materials that can withstand the corrosive effect of this liquid, as well as the erosive cutting action of the blow-down itself. When acid cleaning is anticipated, purchasers of blow-off valves should so indicate. The seatless valve, for instance, would then employ a type 317 stainless-steel plunger, rather than the Standard "Nitralloy"; and the lower gland would be made of "Ni-resist" rather than of chromium-plated steel.

Methods of Operation

Usually, blow-off valves are manually-operated, by handwheel or lever. A handwheel is employed where rotary motion is required to open or close the valve. Normally, clockwise rotation closes the valve. Some manufacturers introduce a gear-reduction for ease of operation. Quick-opening valves are usually direct lever operated, although some use a gear segment or rack arrangement for easier operation.

Remote operation has been introduced in some power plants. Electric motor operators, controlled remotely by push-button stations, have been used in some modern plants where the tendency is toward automation. Others have used hydraulic and pneumatic cylinder operation.

Maintenance of Blow-Off Valves

Materials used in modern blow-off valves tend to minimize maintenance. Packing is generally the only important item necessary to be kept in stock. Every time a valve is disassembled new packing should be installed.

Since blow-off valves operate at saturated-steam temperatures, a high-temperature oil is recommended for maintenance lubrication. It is good practice to lubricate a valve just before it is operated, to guarantee clean lubricant in the proper place when it is most needed.

A new development in the blow-off valve field has been the use of hard-seat valves, with integral seats. By depositing the hard-facing material, usually stellite or its equivalent, directly in the body of the valve, the screwed-in-seat connection is eliminated. Formerly valve seats were threaded in, and sometimes sealed by a gasket or seal-weld. Now this is eliminated. Should the integral seat need attention, the manufacturer offers a tool which can recut or regrind the seating surface while the valve body remains in place in the pipe line. THE END

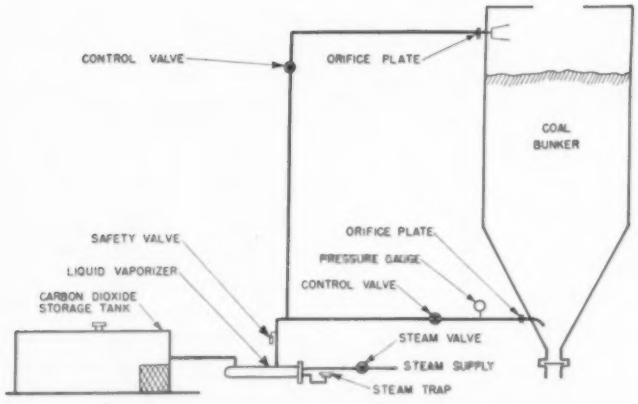


Fig. 1. Equipment consists of CO_2 storage unit, a steam-heated vaporizer, piping and manual means to control flow of the gas

How to Use CO_2

Carbon dioxide fire protection for coal bunkers is feasible and practical as long as it is properly applied and leakage is not out of line. Bunkers must be tight

By H. V. WILLIAMSON *

ONE OF THE MAJOR nuisance problems of industrial coal handling and storage involves the tendency of coal to heat spontaneously. This is particularly true of soft coals stored in large industrial bunkers. In live storage there is relatively little danger of overheating, but if the movement of coal must be delayed for an extended period, the temperature may become critical. A fire in a large coal bunker poses a problem that is both expensive and upsetting to normal operations.

It is well known from a theoretical viewpoint that the application of an inert atmosphere will prevent combustion by excluding oxygen. In open coal pile fires or in poorly constructed storage bins such large volumes of inert gas would be required to accomplish this that the cost would be prohibitive; but this is not necessarily true when the container is relatively tight, as in a well-constructed bunker. If the inert gas is applied efficiently, the quantity required will not be excessive, and the protection afforded will be well worth the cost.

In Co_2 application the following points are important:

1. The bunker must be tightly constructed so that possible leakage is reduced to a minimum.
2. Concrete bunkers will in general have more leakage than steel bunkers.
3. Carbon dioxide must be vaporized so that it can be applied at steady controlled rates.
4. The application rate must be high enough to prevent leakage of air into the bunker.
5. Each situation may have its own peculiar problems and should be reviewed by a qualified fire protection engineer familiar with the use of carbon dioxide.

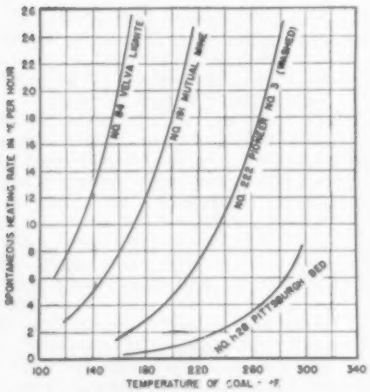


Fig. 2. Effect of temperature and rank on spontaneous heating in coal

Two Examples

Commonwealth Edison Co used this principle to provide fire protection for two large multiple outlet coal bunkers at its power generating station near Lockport, Illinois. Each bunker has a coal capacity of approximately 2800 tons. The system is designed to inject carbon dioxide vapor into each bunker just above the outlet valves, as shown in Fig. 3. Carbon dioxide can also be injected into the space above the coal to eliminate any possibility of explosion of combustible gases that may be generated in the event of overheating. Carbon dioxide is supplied from a 12½-ton capacity bulk low-pressure storage unit.

The Edison station carbon dioxide system is used to prevent or control spontaneous heating in the coal bunkers on occasions when the coal bunkers must remain full as a result of an unplanned outage of a boiler. However, it was not installed solely for this purpose as it also provides protection against other types of generating station fire hazards and is available for hydrogen-filled generator purging.

In another installation, at the Wisconsin State Prison in Waupun, Wisconsin, carbon dioxide is used to protect a group of four concrete bunkers. These bunkers in the past have given trouble, particularly during the summer season, when some active fires have developed. The bunkers are designed so that the lower part contains dead storage coal while the upper section is utilized for live storage. Coal is transferred by means of a conveyor system from the bottom of one bunker to the top of any other bunker to maintain their supply of live coal. Each bunker has a capacity of about 400 tons of dead storage and 100 tons of live storage.

Carbon dioxide for this system is supplied from a 4-ton bulk storage unit. The capacity of the storage unit was based on the economics of delivering carbon dioxide as needed rather than on the amount that might be needed for any one fire situation. The gas is used at a relatively low rate so that there is ample time to arrange for additional deliveries as required.

Spontaneous Heating

Review of principles governing spontaneous heating will help to explain why and how carbon dioxide can be effectively used. Spontaneous heating is merely the tendency for many materials to oxidize or combine with oxygen at normal ambient temperatures. The process produces just as much heat per volume or oxygen consumed as it does under normal fire conditions. The difference is that the rate of oxidation or combustion is very low when temperature is low.

The oxidation rate of coal at ambient temperatures is determined by its rank, its exposed surface area and the percentage of free oxygen in the atmosphere permeating the coal. Coal of low rank will have a higher oxidation rate than harder coal under the same conditions, as illustrated in Fig. 2. Likewise, if the coal is crushed to a finer particle size, more surface area will be exposed and the oxidation rate will be increased. A reduction in the free oxygen content in the atmosphere permeating the coal will reduce the rate of oxidation almost proportionately. Oxidation will of

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for Coal Bunker Fire Protection

course continue at a reducing rate until essentially all of the free oxygen has been used up.

Heat produced by spontaneous combustion will be absorbed by the coal so as to raise its temperature slightly. As the temperature increases, the rate of oxidation will also increase. Some of the heat produced will be dissipated to the outside by conduction through the coal and by local convection currents. However, as long as the rate of heat production by spontaneous combustion is greater than the rate of heat dissipation, the temperature of the coal will continue to increase. Since the coal provides its own thermal insulation, the volume of coal present becomes an important factor in the development of hot spots leading to actual fire conditions.

In a typical coal bunker, the atmosphere permeating the coal will usually be so low in oxygen so as to be practically inert. In other words, the oxygen in the original atmosphere is soon removed by spontaneous oxidation. The heat produced is not enough to increase the temperature of the coal appreciably because relatively little oxygen is involved. Spontaneous heating would then stop at this point except for the fact that bunkers are never absolutely airtight.

Development of excessive temperatures in coal bunkers depends on a flow of fresh air entering through leaks at the discharge valve or diffusing down from the top. Any increase in coal temperature over outside air temperature will produce a chimney effect that will increase the flow of air entering through leaks near the bottom. Hot spots will therefore tend to develop above the discharge valves or other bottom leaks.

Use of Inert Gas

Since the problem is one of leakage, the answer is to keep the air from entering. This can be done by injecting carbon dioxide near the bottom so as to produce a small positive pressure to keep the air out. By applying carbon dioxide continuously at a uniform and relatively low rate, the supply of fresh air will be eliminated, thus preventing any further combustion. The hot spot will then cool off as the heat is gradually dissipated to the walls of the bunker.

Coal will absorb several times its own volume of carbon dioxide gas. In other words, it would take more carbon dioxide to fill a bunker that is full of coal than one that is empty. Actually the gas is absorbed very slowly and the effect on the rate of application to prevent inward leakage of air is negligible. It would be wasteful to attempt to fill the bunker quickly since the application, to be effective, must be continued in any event.

Application of carbon dioxide near the bottom will result in gradually developing a carbon dioxide atmosphere throughout the bunker. Since carbon dioxide is about 50 per cent heavier than air, the chimney effect will be greatly reduced or entirely eliminated even with the coal at relatively high temperature. The fact that carbon dioxide is heavier than air is also helpful in preventing any circulation of air downward from the top.

Main problem at the top of the bunker is the possibility that an explosive atmosphere may develop in the space above the coal. The heating of the coal by spontaneous combustion drives off substantial quantities

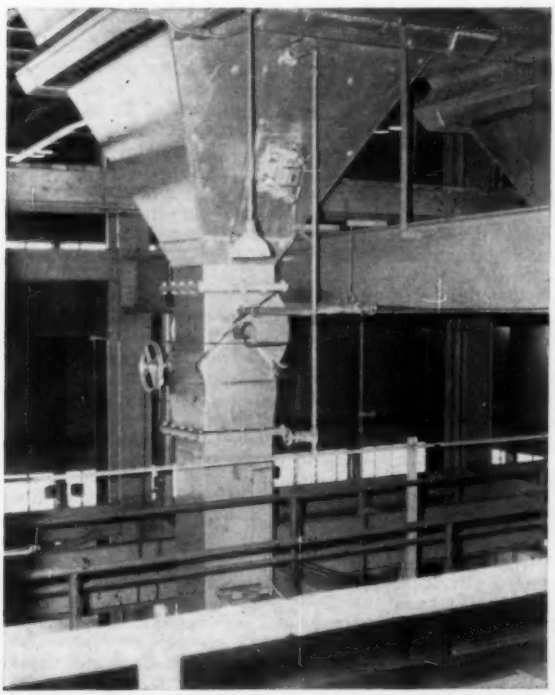

Fig. 3. CO_2 is piped into coal bunker just above discharge vibrator in installation at Commonwealth Edison station

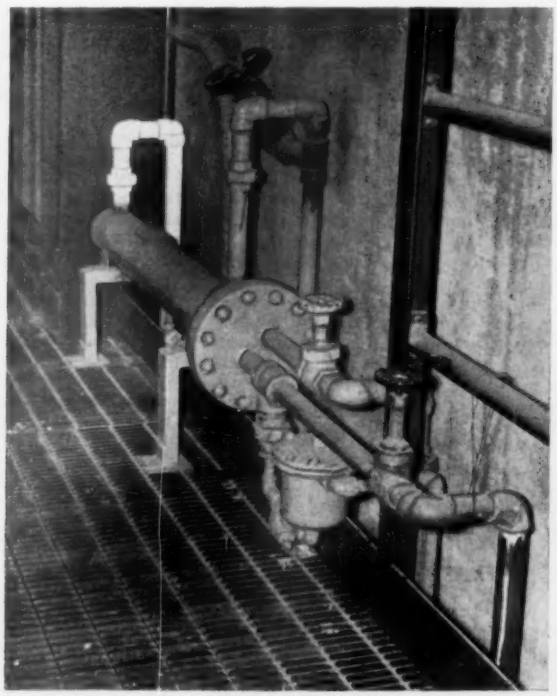

Fig. 4. View of the liquid carbon dioxide vaporizing unit at Commonwealth Edison. Note frosted liquid inlet pipe

of methane. Carbon monoxide may also be produced. Application of carbon dioxide at the bottom will displace these lighter gases to the surface. Therefore, where the top of the bunker is substantially enclosed, it is desirable to inert the top space at the same time that carbon dioxide is applied at the bottom. Application at the top may be discontinued when danger of an explosion has passed.

It should be noted that the application of carbon dioxide at the bottom does not in itself remove any substantial amount of heat from the coal. It merely shuts off the supply of air so that no additional heat will be produced. The application must be continued until cooling is accomplished by natural means. This may be a matter of days or weeks depending on the temperature reached and the mass of coal involved. Complete and permanent cooling or extinguishment may not always be practical because the condition that led to overheating in the first place may continue to exist. Important point is that spontaneous heating or actual fire can be controlled by this method so that the coal can be used or moved in a normal manner.

Equipment

Flow diagram for a typical system is shown in Fig. 1. Equipment consists essentially of a carbon dioxide storage unit, a steam-heated vaporizer, piping and manual means to control the flow of gas into the bunker.

Storage unit consists of an insulated pressure vessel provided with a refrigeration system so as to maintain a temperature of about 0 F. At this temperature the vapor pressure of the liquid carbon dioxide is approximately 300 psi. The pressure vessel is designed for a maximum working pressure near 350 psi, and safety valves are used for emergency pressure release in case of failure of the mechanical refrigeration system. Standard air-cooled refrigeration compressors are used. These are very reliable and require very little maintenance.

This method of storage is termed Low Pressure as opposed to the relatively High Pressure of carbon dioxide stored in cylinders at ambient temperature. The low pressure method is used commercially throughout the industry for transporting and storing carbon dioxide in bulk quantities. Liquid carbon dioxide is transferred from a transport tank truck to the storage unit by means of a pump and connecting hose lines. The quantity of carbon dioxide in the storage unit is continuously indicated by means of a liquid level gage.

Since the carbon dioxide is stored as a liquid, it is necessary to utilize a vaporizer so that it can be applied as a gas. Any attempt to apply the carbon dioxide in its liquid form would result in the formation of dry ice near the discharge outlet and blocking or freezing of the orifice itself. The discharge rate would therefore be erratic and not subject to accurate control. The vaporizer is merely a steam-heated heat exchanger especially designed to vaporize liquid carbon dioxide. Vaporizer used on the installation at the Commonwealth Edison Company plant is shown in Fig. 4. This unit has a maximum vaporizing capacity of approximately 2000 lb of carbon dioxide per hr.

Flow control means consists of a throttle valve in series with a pressure gage and the discharge orifice. By adjusting the throttle valve so as to control the pressure ahead of the discharge orifice, the flow rate can be very accurately controlled. A pressure-reducing valve can be used in place of the throttle valve to hold pressure settings closely with less attention. A simple calibration curve for the size of orifice used serves to indicate the rate of application based upon the pressure reading.

Piping is relatively simple, since 1-in. steel pipe is large enough for most runs. Joints may either be threaded with extra heavy fittings or welded. The connection to the bottom of the bunker is provided with a downwardly directed extension on the inside to keep fine coal from entering the pipeline. Connection at the top of the bunker is provided with a low velocity outlet nozzle to avoid turbulence that might stir up a cloud of coal dust.

Cost

Important factor so far as the economics of using carbon dioxide is concerned is the rate at which the gas must be applied to achieve the desired results. This determines the total quantity of carbon dioxide that might be needed in any one fire situation, and it also tends to dictate the size of storage tank required. The storage tank is of course the main item of equipment cost.

Rate of application depends upon the potential air leakage that may be encountered which in turn depends upon the design and construction of the bunker or storage container. In general, steel bunkers can be considered to be comparatively tight although there will be air leakage at the discharge valve. Even though the valve utilizes a sliding gate or similar device to shut off the flow of coal, it is not designed to shut off tightly insofar as gas leakage is concerned. The space around the gate or shutoff valve will be filled with coal; however, this will have little effect on the leakage rate.

In a series of tests on a 500-ton steel bunker with two discharge valves it was found that a carbon dioxide discharge rate of about 25 lb per hr was sufficient to stop leakage at the bottom. A somewhat higher rate, in the order of 50 to 100 lb per hr, would be required to maintain high carbon dioxide concentrations in the upper part of the bunker. These tests were conducted with the coal at normal storage temperature. A somewhat higher rate would probably be required if a severe fire condition existed.

In another test in connection with the concrete bunkers at the Waupun installation it was found that the carbon dioxide had to be applied at a rate of about 200 lb per hr. Volume of this particular bunker section was approximately 14,700 cu ft. This result was obtained even though the discharge valve and a separate clean-out opening were both sealed as well as possible.

It seems clear that more carbon dioxide would be required to provide suitable protection for a concrete bunker or coal storage silo than for a similar steel unit. In the first place, concrete will be somewhat porous to the flow of a gaseous medium such as air. Porosity can vary over a wide range depending on the quality of the concrete. Although the actual flow of air per sq ft of area may be very small, it becomes significant in relation to the large concrete areas that are involved. Secondly, the nature of concrete construction makes it more difficult to provide tight-fitting valves and seals for openings. Finally, there is the possibility that actual cracks may develop through the walls. These factors appear to indicate that concrete bunkers are more apt to develop fires than similar steel bunkers.

Based on the above observations a reasonable discharge rate to use in estimating the requirements for steel bunkers would be about 100 lb of carbon dioxide per hr per outlet valve. For concrete bunkers in good condition the minimum rate should be about 200 lb of carbon dioxide per hr per outlet valve.

Capacity of the carbon dioxide storage tank should be sufficient to maintain the required application rate for a minimum of 24 hours or more depending on the time required to arrange for additional deliveries from the supplier. Size of the storage tank may also have a bearing on the delivered cost of carbon dioxide since larger deliveries are more economical.

Average cost of carbon dioxide will range from $100 to $150 per ton depending on location and other factors. The cost of equipment for a system using a 4-ton storage tank will be about $8000. This includes the vaporizer and other miscellaneous parts. For a system using a 12½-ton storage tank, the equipment cost would be about $14,000. To these figures would have to be added the cost of piping and installation.

In regard to the economics of fire protection for bunkers, consideration should be given to the possibility that other fire hazards can be protected from the same carbon dioxide storage unit. Typical hazards may involve storage and use of combustible liquids such as paint, gasoline or various lubricating and fuel oils. Carbon dioxide is also ideal for electrical equipment since it is a non-conductor of electricity and leaves no contaminating residue. THE END

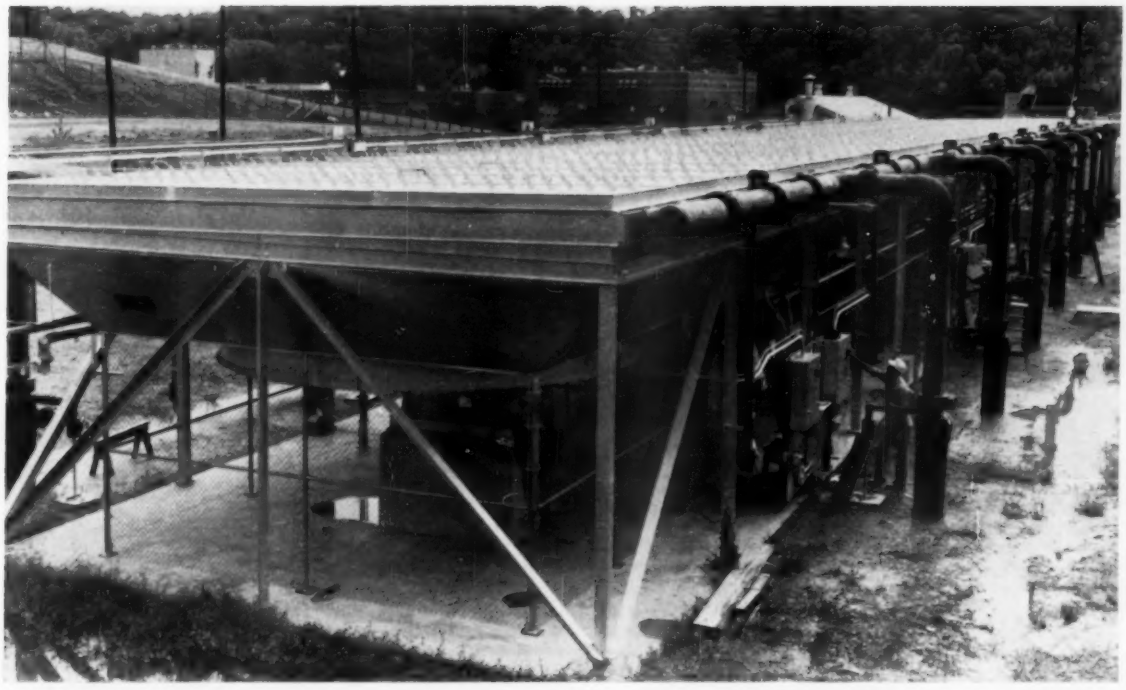

Fig. 1. Trane air-cooled heat exchanger 178 ft long cools new Oak Ridge Research Reactor. Unit removes 68,000,000 Btu of heat per hour in cooling reactor core water from 131.4 F to 120 F. Aluminum construction helps water purity

This Fluid Cooler Sends 12,000 gpm To Research Reactor

COOLING MEDIUM for the new Oak Ridge Research Reactor is water — large quantities of water. The 20- to 30-megawatt unit has two cooling systems. In the major system, more than 12,000 gpm are supplied to ORR by the huge heat exchanger shown here.

This air-cooled heat exchanger, or Fluid Cooler, as it is called, removes 68,000,000 Btu of heat per hour from the reactor core during irradiation periods — enough to provide warmth for more than 900 homes.

Although the reactor core requires such a tremendous flow of water, it should be explained that the water is used over and over again because the cooling system is a closed loop.

The cooler, 178 ft long, 24½ ft wide and 14½ ft high, has aluminum coils and eight 16-ft diameter aluminum fans. Ambient air temperature design is 95 F.

Aluminum construction was specified for the heat exchanger for two reasons, the first being that an item of major importance is the maintenance of a high degree of water purity. *continued on next page*

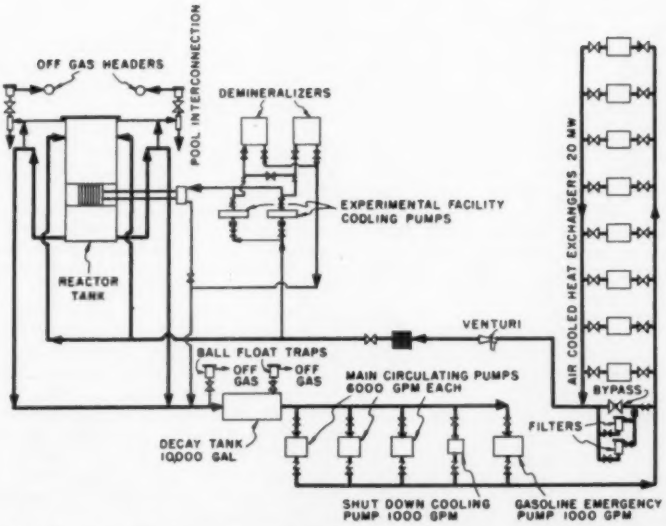

Fig. 2. Cooling water leaves reactor tank, flows to decay tank, moves to cooler, is cooled, passes through strainer before re-entry

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Second reason for specifying the use of aluminum was a preference to have all major components of aluminum construction; the reactor and fuel elements are also primarily of aluminum construction. Water in the system is maintained at high purity by ion demineralizers, which remove dissolved solids and radioactive ions from the water.

The heat exchanger cools water coming from the reactor core at 131.4 F to 120 F. Choice of temperature differential and absolute temperature was based on a study of necessary heat transfer in the reactor core, operating problems and economic considerations.

When the heated water leaves the exit header of the reactor tank, it flows through underground pipes to a pump house where three main circulating pumps for the cooling system are located. Each is a 6000-gpm pump operating at approximately 70-ft head and driven by a 250-hp motor. The water passes through the aluminum coolers, where the heat is transferred to the air, and the water cooled for reuse by the research reactor.

Primary purpose for selecting an air-cooled heat exchanger lies in the ease of operation and freedom from the necessity of large amounts of make-up water and chemicals which would be required with a heat exchanger-water tower combination. In addition, it is expected that fewer operating personnel and less maintenance will be necessary with the air-cooled system.

In order to prevent internal freezing in the heat exchanger units during shutdown in cold weather, each unit is provided with a set of remotely operated louvers and steam-heated finned-pipe wall fin sections below the tubes. Louvers in the closed position minimize escape of air through the top of the unit, and steam supplied to the finned-pipe sections provides heat below the tubes. During long shutdown periods, the units are vented and drained.

The second cooling system, independent of the reactor tank cooling system, removes heat from the pool of water surrounding the reactor tank. This heat comes from energy released to the water as it stops radiation from the reactor, and from heat transfer from the warmer reactor tank. Pool temperature is kept below 100 F to minimize humidity in the building.

Provision is made for the circulation of this pool water through the reactor core, should such a procedure be necessary under an emergency.

Additional safety precautions with regard to the cooling system are provided. If the level of the water in the storage pool is lowered by an unsafe amount, an alarm sounds to warn personnel of the condition. In addition, temperature and flow-measuring devices sound alarms and initiate reactor shutdowns if unsafe conditions are detected.

If, for some reason, all water is lost from the main reactor cooling system and also from the pool, plant process water may be sprayed on the reactor core to dissipate afterheat.

The new $4,500,000 Oak Ridge Research Reactor is being used largely for radioisotope production, dynamic loop tests to determine the effect on fluid fuels and on the engineering equipment associated with them; also the irradiation of fluid fuels in quantities large enough to permit chemical studies of continuous fuel processing systems, "conventional" neutrons, and for solid-state physics and metallurgy investigations of the effects of radiation on engineering materials, and basic studies of the properties of metals, alloys and ceramics. It is operated for AEC by Union Carbide Corp. THE END

Case of the Freezing Cooler . . . and Ammonia in the Brine

By C. T. BAKER *

DURING the war years when calcium chloride was both expensive and difficult to obtain, the owners of a 30-ton ice-manufacturing plant decided on the use of salt to strengthen their calcium brine when the salometer indicated the need for additional strength.

After adding salt to the calcium it was only a short time until a film of ice was formed on the interior of the brine cooler tubes. Thinking that more salt was needed, more was added.

However, this simply made matters worse; what happened was that instead of adding strength to the brine, it did just the opposite.

Since the ice film was still growing and tank capacity was falling off, a supply of calcium chloride was finally obtained and used to bring the brine strength up to normal.

However, this did not clear up or correct the trouble that stemmed from the deposits of a light, white precipitate; also, some solid salts in the tubes of the brine cooler greatly interfered with normal heat flow between the brine and the evaporating refrigerant.

It is true that at some temperatures and at certain strengths of calcium chloride brine, some salt could be added to calcium brine and remain in solution. For example, in a brine having a 65 per cent water, 20 per cent pure calcium brine, and 15 per cent common or pure commercial salt (weight percentages), the sodium chloride (common salt) may be expected to precipitate out of solution as a solid over a considerable range of temperature.

It is difficult to add salt to calcium chloride brine in the quantities required by the average ice plant and maintain safe brine strength.

Another interesting observation in connection with the calcium-salt mixture situation is that if a calcium chloride solution were reduced to say 10 per cent, it would mean that 1½ per cent would be the upper limit of salt that could be added without forming troublesome precipitate.

No matter how much salt is added beyond the very small amount that could be dissolved in any given case, the brine strength would not be increased; it would simply mean an increase in the amount of deposit on the bottom of the tank and a decrease in brine strength.

Ammonia in the Brine

Another situation was one in which an ice can came loose from the ice hoist while the can was being pulled from the tank, and in falling struck the coils which were located between the rows of cans, breaking one of the pipe sections at a flange.

This not only poured a large quantity of ammonia into the brine but also, since the compressor was allowed to operate for several hours after the accident, a large quantity of brine was pulled into the coils after the compressor had lowered the suction pressure below that of the static head on the bottom pipe of the 10-pipe-high coil where the break occurred.

The night man claimed he knew nothing of the break until several hours after it occurred. It required several days to remove the brine from the ammonia equipment. In fact, much of the ammonia had to be dumped overboard. This was true of the coils, which were blown out with compressed air to remove the mixture of brine and liquid refrigerant that had collected.

In this case, the brine was discarded, the tank thoroughly cleaned and new brine substituted for the old. The compressor cylinder and valves were badly rusted and required many hours of labor to remove the rust and pockets of brine.

*Consulting Engineer, Atlanta, Ga.

CONSTRUCTION NEWS

Wilsonville, Ala. — Southern Electric Generating Co, jointly owned by the Alabama and Georgia Power companies, two of the four operating subsidiaries of the Southern Co, has work under way on new steam-electric generating plant located near here. Plans call for the installation of four steam-electric generators, each with a capacity of 250,000 kw, the first two of which are scheduled to be placed in operation by the summer of 1960. The third and fourth units will be placed in operation in 1961 and 1962, respectively. Station when in full operation will have some 170 full-time employees and when completed in 1962 will represent an investment of some $150,000,000.

Eureka, Calif. — Pacific Gas & Electric Co, 245 Market St, San Francisco, Calif., has plans under consideration for the installation of a large atomic power plant at company's Humboldt Bay plant here. New installation, awaiting approval of the AEC, will have an initial capacity of 60,000 kw and will be designed and constructed by the Bechtel Corp, 225 Bush St, San Francisco. General Electric Co, Schenectady, N. Y., will supply the electrical and nuclear equipment necessary for the complete installation. No estimate of cost announced.

Los Angeles, Calif. — Los Angeles Dept of Water & Power, 311 S Spring St, has plans under way for major expansion of city's Haynes Steam Plant at Seal Beach, Calif. Work will include installation of two steam-turbine generating units each with an initial capacity of 200,000 kw on existing foundations, high-pressure boilers and auxiliary equipment, first unit scheduled for completion by early 1960. Entire project is estimated to cost approximately $15,000,000.

Denver, Colo. — Public Service Co of Colorado, 15th and Champa Sts, has plans under way for the construction of new electrical distribution center, located at West 8th Ave, and Platte River. Work on the new facility, already under way, is reported to cost in excess of $1,200,000. Standards & Fields Engineering Co, Denver, Colo., are the engineers of the new installation scheduled for completion by early 1959.

Rangely, Colo. — Moon Lake Electrical Association, Vernal, Utah, has plans under consideration for large power plant addition at local station here. Expansion when completed will represent a capital outlay in excess of $4,000,000. Company has made application to the REA for loan in like amount to cover cost of addition. C. H. Guernsey & Co, 2701 North Oklahoma St, Oklahoma City, Okla., consulting engineers.

Norwalk, Conn. — Connecticut Light & Power Co, 266 Pearl St, Hartford, Conn., has announced that they will go ahead with construction plans for the erection of a large steam-electric generating station on Manresa Island. The State Supreme Court of Errors, in a unanimous decision, upheld the State Public Utilities Commission in approving the project over the protest of shoreline residents, over a five-year period. Company plans to get work under way at once on construction of the new station, which will involve an expenditure of $25,000,000, on the 23-acre site originally purchased for the purpose.

Wilmington, Del. — Delaware Power & Light Co, 600 Market St, has announced plans for the expenditure of better than $90,000,000, for the expansion and improvement of company generating and distribution facilities over the next five-year period. Construction of an 85,000-kw generating unit at company's Indian River Power Station is included in the long-term program. Company has plans for the construction of a major addition to Edgemoor Power Station starting in 1960. Installation will have an initial capacity of 150,000 kw and is scheduled for completion by the summer of 1962.

Ann Arbor, Mich. — Parke, Davis & Co, Inc, Joseph Campau Ave, at the River, Detroit, Mich., has approved plans for the construction of a large medical research laboratory. New facility will comprise a three-story 130 by 330-ft glass and aluminum laboratory, a two-story, 85 by 252-ft administration building and a 21,000-sq-ft power plant installation. Total cost of installation including land, equipment and power installation reported to be about $10,000,000. Barton-Malow Co, 2631 Woodward Ave, Detroit, Mich., has been awarded the construction contract. Work is expected to proceed at once.

Elk River, Minn. — The Atomic Energy Commission, Washington, D. C., has awarded construction contract to the ACF Industries' Nuclear Products-Erco Division for the construction of large nuclear power project here. New Elk River facility will be of the boiling water type and will have an initial capacity of 22,000 kw. The AEC plans to spend approximately $11,500,000 on the project, including about $9,269,000 to ACF. Work is already under way for completion scheduled in 1960. Rural Coöperative Power Association of Elk River, Minn., will purchase steam produced by the reactor from the commission.

Omaha, Neb. — Omaha Public Power District, 17th and Harney St, has awarded contract in the amount of $4,793,980, to the Combustion Engineering Co, Inc, for the installation of high-pressure boilers on Unit No. 4 at company's North Omaha Power plant here. Work is proceeding on schedule for completion by late 1959.

Piqua, Ohio — The Atomic Energy Commission has announced plans for the construction of a large nuclear electric power plant on large plant site recently acquired at a construction cost of $12,300,000, with the city of Piqua, providing conventional facilities worth an additional $4,000,000, for a total investment in excess of $16,000,000. The Atomic International Division of North American Aviation Co, 5601 Imperial Highway, Los Angeles, Calif., will be in charge of installation of the 12,500-kw reactor which is scheduled for completion by July of 1961. New plant will show the use of a "high boiling point hydrocarbon" as a reactor cooling agent. Piqua power reactor to be run by the city will be fueled by slightly enriched uranium.

Shelby, Ohio — Municipal Water & Light Dept, City Hall, has announced plans for the expansion and improvement of Municipal electric power plant. Plans call for increased generating capacity at a cost reported to be about $3,701,700, scheduled for completion by late 1959. William C. Kammerer & Associates, 1900 Euclid Ave, Cleveland 15, Ohio, consulting engineers of the new installation.

Harrisburg, Penna. — General State Authority, 18th and Herr Sts, has awarded contract to the Spera Construction Co, 1625 N. Front St. Work to include revamping of main boiler plant and electrical system at State Farm Show Bldg, Cameron and Maclay Sts, Harrisburg. Work reported to cost in excess of $135,000 will get under way soon for completion by January 1959.

Magna, Utah — Utah Copper Division, Kennecott Copper Corp, Kearns Bldg, Salt Lake City, Utah, has approved plans for major addition to electric power plant here, with installation of additional generating equipment for increased capacity. New facilities, reported to cost in the neighborhood of $16,000,000, will be started soon, with Kuljian Corp, 12 North Broad St, Philadelphia, in charge of construction. New power plant addition is scheduled for completion by late 1959 or early 1960.

Clinchfield, Va. — Clinchfield Coal Co, a Division of the Pittston Co, has awarded Link-Belt Co a contract for one of the largest automated coal preparation plants ever built in this country. The new plant will wash, dry and screen 1500 tons of run-of-mine coal per hr. Scheduled for completion late in 1958, the plant will utilize the heavy-media separation process for the preparation of metallurgical and steam coal. No estimate of cost announced.

Rothschild, Wis. — Wisconsin Public Service Corp, 1029 Marshall St, Milwaukee, Wis., has plans under way for addition to steam-electric generating plant at company's Weston Power plant, near here. A new steam-electric generator with initial capacity of 75,000 kw will be installed with auxiliary equipment and will be placed in line by early 1960. When in operation new installation will bring system's total capacity to 500,000 kw. Work will begin soon and the construction crew will range from 40 to 200 men at various stages of the job. Cost of entire installation when completed reported to be about $15,000,000.

Power Engineering handbook

Introduction to Steam Power

This is the third chapter in Commonwealth Edison Co's basic course on steam power fundamentals. The series began in this department in May. Developed for use as after-hours education material, this course was authored by R. A. Dannells, F. W. Beeman, the late J. R. Bonnell and J. B. Burkhardt, all of the Commonwealth Edison system. Fourth chapter will cover the Units and Methods of Measurement

3—Combustion of Coal

General Principles of Combustion

1. Process of combustion
   The chemical reaction between oxygen and fuels that results in the evolution of heat at such a rate as to cause an increase of considerable magnitude in the temperature of the substance involved.
2. Objects of combustion
   a. The orderly, direct, and rapid production of heat which is to be transferred to other bodies, as in the furnace of a boiler.
   b. The development of mechanical energy by means of the direct action of the products of combustion on a piston.
   c. Formation of a more suitable kind of a combustible, such as coke.
3. Factors determining the rate of combustion of solid fuel
   a. Temperature available.
   b. Rapidity with which the air and fuel are brought together.
   c. Character of the surface of the fuel.
   d. Ratio of the surface area to volume.
   e. Rate of diffusion of the air to the fuel surface.
4. Requirements for complete combustion
   a. Fuel and air must be properly mixed at all points in the combustion zone.
   b. Sufficient air must be supplied to furnish the required oxygen.
   c. Temperature at those points must be adequate to maintain combustion.
   d. There must be time allowed for the process to be completed before encountering cold walls or tubes.
5. Facts about combustion expressed by chemical equations
   a. Number of atoms must be the same before and after combustion.
   b. Relative weight of each substance is represented by the product of its formula weight and its formula coefficient.
   c. Relative volumes of gases entering into combination are shown by their respective formula coefficients.

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fold along this line—outside edges toward you

Burning of Coal

1. Burning of carbon
   a. Carbon is the principal combustible of most fuel.
   b. Carbon unites with oxygen to form carbon dioxide.
   c. One pound of carbon unites with $2\frac{2}{3}$ lb of oxygen to form $3\frac{2}{3}$ lb of carbon dioxide.
   d. The heat liberated when 1 lb of carbon is burned to carbon dioxide is 14,600 Btu.
   e. As air is composed of 75.5 per cent nitrogen, 23.3 per cent oxygen and 1.3 per cent inert gases, by weight, it is necessary to supply 11.52 lb of air to burn 1 lb of carbon.
2. Burning of hydrogen
   a. Hydrogen is the second most important combustible in coal.
   b. Hydrogen unites with oxygen to form water vapor.
   c. One pound of hydrogen unites with 8 lb of oxygen to form 9 lb of water vapor.
   d. The heat liberated when 1 lb of hydrogen is burned to water vapor is 62,000 Btu.
   It takes 34.6 lb of air to supply the oxygen necessary to burn 1 lb of hydrogen.
3. Burning of sulfur
   a. Sulfur forms only a small part of the combustible in coal; in fact, its presence is not desirable because of the corrosive action of its gases.
   b. Sulfur unites with oxygen to form sulfur dioxide.
   c. One pound of sulfur unites with 1 lb of oxygen to form 2 lb of sulfur dioxide.
   d. The heat liberated in burning 1 lb of sulfur is 4000 Btu.
   e. 4.32 lb of air are necessary to burn 1 lb of sulfur dioxide.
4. Air theoretically required for burning of coal
   a. The ultimate analysis of the coal is necessary to calculate amount.

Carbon	74.79
Hydrogen	4.98
Oxygen	6.42
Nitrogen	1.20
Sulfur	3.24
Water	1.55
Ash	7.82

   b. The oxygen to be supplied:

To burn the carbon	
0.7479×2.667	1.9944 lb
To burn the hydrogen	
0.0498×8	0.3984 lb
To burn the sulfur	
0.0324×1	0.0324 lb
Total oxygen required	2.4252 lb
Less — oxygen in coal	.0642 lb
Oxygen required from atmosphere	2.361 lb

   c. It takes 4.32 lb of air to supply 1 lb of oxygen: $2.361 \times 4.32 = 10.2$ lb air required.
5. Air actually supplied for combustion of coal
   a. In burning coal in a power plant more air must be supplied than that theoretically required, because of the inability of maintaining a perfect mixture within the furnace.
   b. The amount varies with the fuel and type of furnace; 30 per cent to 50 per cent excess air is the usual practice.
   c. The amount of excess air supplied to any furnace may be determined from a flue gas analysis.

Flue Gas Analysis

1. Products of combustion
   a. Factors determining character and amount: 1. the nature of the fuel; 2. the air supply; 3. conditions under which the combustion takes place.
   b. Products of complete combustion with a theoretical amount of air: 1. carbon dioxide (CO_2); 2. nitrogen (N_2); 3. water vapor (H_2O); sulfur dioxide (SO_2).
   c. Free oxygen will be included if excess air is supplied.
   d. The gaseous products of complete combustion are colorless and invisible at furnace temperatures.
   e. Carbon monoxide (CO) gas will also be present if combustion is not complete.
2. Obtaining a gas analysis
   a. Biggest problem in the analysis of fuel gases is to obtain a true average sample.
   b. Analysis as made in commercial practice is called volumetric.
   c. Apparatus usually employed is called an Orsat.

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d. This apparatus consists of a measuring burette and pipettes that contain the necessary absorbing reagents. The gases are first passed through a solution of caustic potash which removes the carbon dioxide. The sample is then passed through a solution of potassium pyrogallate to remove the oxygen. If CO is present it may be removed by passing the gas through a solution of cuprous chloride. The remainder of the sample will be nitrogen.

e. There are several types of electronic and semi-electronic combustion analyzers which measure the oxygen left in flue gases.

Heat Losses in Burning Fuel

1. Heat loss discharged through stack
   a. Heat loss in dry chimney gases: 1. greatest of all heat losses; 2. depends upon nature of fuel, type, and proportions of furnace; 3. loss controlled by controlling the weight of the products of combustion, and temperature difference between air entering and gas leaving.
   b. Heat loss due to evaporating of moisture in fuel: 1. this loss is of little consequence in burning coal; 2. coal burns better on a stoker if slightly tempered.
   c. Heat loss due to moisture resulting from the combustion of hydrogen in fuel: 1. with bituminous coal this loss amounts to as high as 4.5 per cent of the total heat value of the combustible; 2. this loss is due to the fact that heat is utilized to superheat the water vapor formed by the combustion of hydrogen.
   d. Heat loss due to moisture in air may be disregarded except in carefully conducted tests.
2. Heat loss due to unburned fuel
   a. Carbon monoxide: 1. carbon monoxide forms about 80 per cent of combustible gases; 2. unless sufficient oxygen is supplied to the combustion zone this CO gas will escape unburned; 3. a small amount of CO represents an appreciable heat loss.
   b. Unburned carbon in refuse: 1. this waste ranges from 0.5 to 10 per cent of the heat value of the fuel; 2. in burning of powdered coal or crushed coal in a cyclone burner this loss is practically negligible.

ARE YOU FOLLOWING POWER ENGINEERING'S series of features on training? Published so far: Training New Men for Power Plant Work (April); for an Industrial Plant (May); for Better Maintenance (See August issue).

This Handler Helps Work on Electric Motors

BY F. E. RILEY

MAINTENANCE and assembly work on the stator frames of electric motors is facilitated considerably by adopting the device shown in the figures. The stator frame, A, Fig. 1, can be adjusted through a full circle about horizontal and vertical axes so that access can be gained easily to all the stator slots from a seated position.

The stator frame is bolted to the plates, B, which are welded to the inside edge of the ring, C. This ring is bent up from steel tubing and should be perfectly circular so that it can rotate within the three grooved rollers, D. The rollers are mounted in simple bearing brackets welded to an outer ring, E. The upper bearing bracket has downward projecting side lugs which prevent the inner ring, C, from disengaging itself from the rollers.

The outer ring, E, carries the bearing brackets and is also bent up from steel tubing. It can be swiveled about its vertical axis by virtue of the upper and lower pivots.

The bent supporting arm, F, is pivotally mounted in a vertical support tube, G, the lower end of which is secured to the edge, H, of a specially constructed bench. The support tube, G, continues downward below the bench and is anchored securely to the shop floor. It is not often necessary to adjust the arm, F, which can be locked in any of three different positions by means of the simple catch plate, I, which engages with notches machined in the upper end of the supporting tube, G.

The lower pivot bearing for the outer ring swivels on the exterior of the vertical support below the bench and can be locked thereto by means of the quick-acting handle, J.

The work bench to which the handler is attached has wings projecting forward on either side for the accommodation of tools and materials. Heavy motor frames can be manipulated easily for servicing the windings or for complete rewinding of the stator slots.

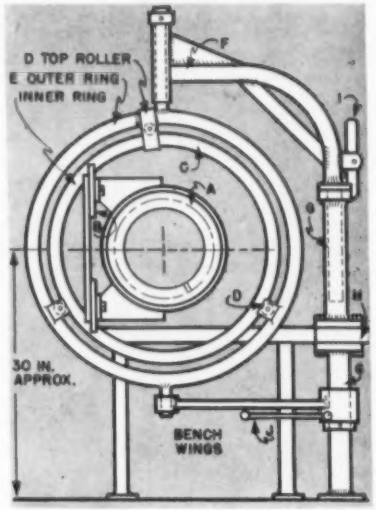

Fig. 1. Side view of handler. For smaller motor frames, packing in the form of lengths of tube is fitted over the bolts holding the frame to the mounting plates, in order to bring handler into line

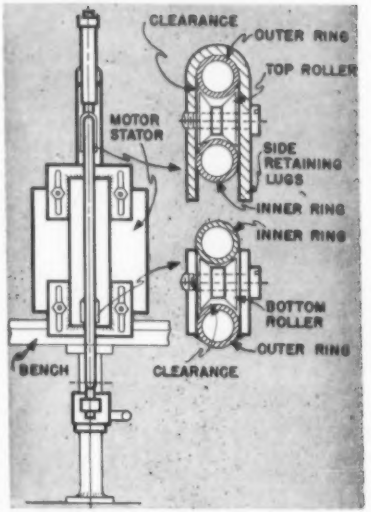

Fig. 2. Front view of handler. The inner and outer rings can rotate relative to one another and usually no clamping of the two is necessary if weight of motor frame is placed centrally

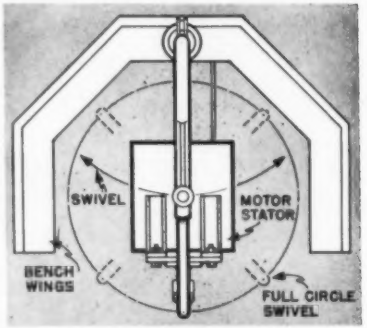

Fig. 3. Top view of handler. If motor frame center of gravity is offset in relation to inner ring center, some clamping may be necessary to hold frame in the desired position. A simple friction clamp can be welded to outer ring to serve for this purpose

POWER ENGINEERING HANDBOOK

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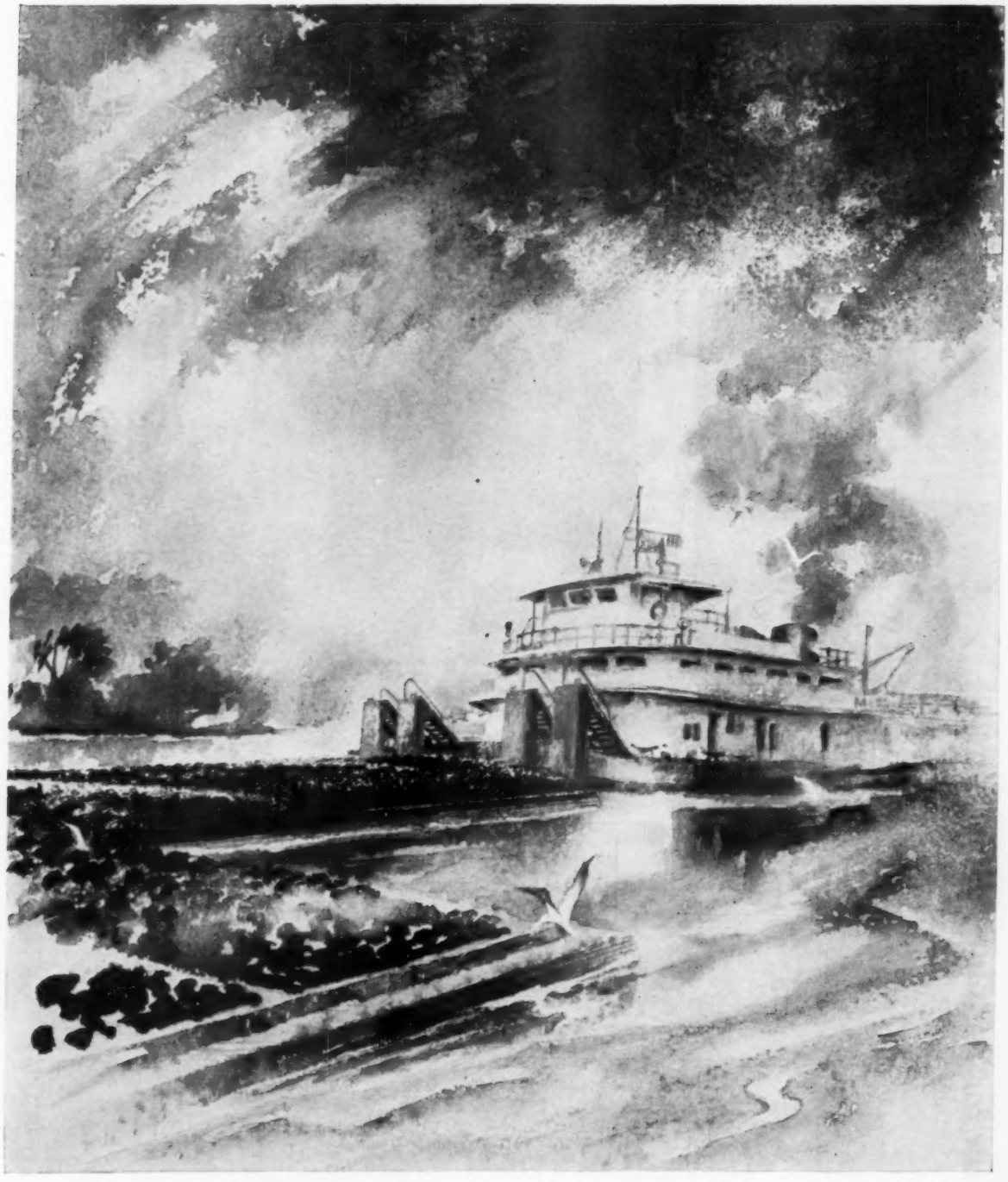

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Better Repair for Tubular Air Heaters

BY R. J. STANLEY*

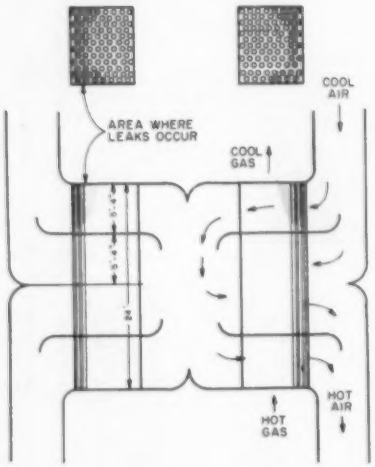

Fig. 1. Nearly all leaks occurred in shaded area

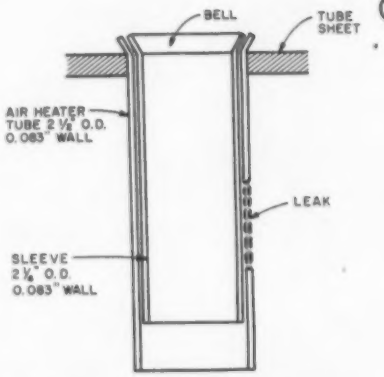

Fig. 2. Caps were removed from leaking tubes and were replaced with sleeves supported by belling

THROUGH THE YEARS air heater tube leaks have been the proverbial thorn in the side at our Delray Plant. Low tube metal temperatures in the area where the cold air enters the air heaters have caused corrosion to proceed at an excessive rate resulting in air heater tube leaks.

When air leakage becomes excessive, the accepted repair has been to tack weld caps on both ends of the leaking tubes while the boiler is out of service. Although effective in controlling air leakage, this method of repair is not entirely satisfactory. As more and more tubes are capped, the draft loss through the air heater increases until boiler output cannot be maintained due to overloading of the induced draft fan. Then it becomes necessary to retube the air heater to maintain plant capability.

During the last few years, six air heaters have been retubed, at the Delray Plant, at a cost of about $40,000 each. Because of this, a study was initiated to evaluate such schemes as steam air preheating and hot air recirculation as a means of reducing corrosion and consequently maintenance cost. Neither of these schemes proved to be economically feasible due mainly to the low plant load factor at the Delray Plant.

But all was not in vain, for although the original schemes were not acceptable, the study led to an even better solution to the problem.

Let's take a look at Fig. 1, which is a drawing of an air heater showing the internal baffles, tubes and associated duct work. Flue gas flows upward through the tubes while cool air flows across the upper end of the tubes and then back across the lower end.

This causes the lowest tube metal temperature, and therefore the greatest corrosion, to occur at the upper end of the front row of tubes. When retubing one air heater, each tube was inspected as it was removed and the location and number of leaks noted. It was found that nearly all of the leaks occurred in the shaded area shown in Fig. 1. As the tubes are capped, they are made inactive and the cool air penetrates further into the tube bundle causing more tubes to corrode until complete retubing is required.

It was suggested that instead of capping leaking tubes they should be repaired by placing sleeves inside the tube which would cover the leak and still allow the gas to flow through the tube.

The air heater on No. 1 boiler, which was scheduled for retubing, was selected for the experiment. The caps were removed from all leaking tubes and replaced with sleeves. Figure 2 shows how these sleeves are installed in the tubes. The sleeves are supported by belling the upper end, as shown in Figs. 3 and 4. Figure 5 shows the sleeve being inserted in an air heater tube.

With the job completed, No. 1 boiler was placed in service and its performance was satisfactory. More time is needed to prove the theory that keeping the front tubes active will prevent the spread of corrosion to tubes farther back in the tube bundle.

Almost all of the sleeves used on No. 1 air heater were 6 ft long, so they extended below the top baffle shown in Fig. 1. However, some 12-ft sleeves were used when the leak was further down the tube. It was found that even if the air heater tube had completely severed, the sleeve could be inserted, bridging the gap, and restoring the tube to useful service.

A stock of sleeves is being maintained at the Delray Plant and all air heaters will be repaired by the new method. As leaks develop in the sleeves, they may be removed and replaced several times, eliminating the need for a complete retubing almost indefinitely. The cost of repairing the No. 1 air heater by this method was about $7000 as compared to $40,000 for retubing.

*Engineer with Detroit Edison Co. This account appeared in *Coal to Kilowatts*, published by the company's Production Department

Fig. 3. Here bell is put on an air heater sleeve

Fig. 4. View of belled sleeve and belling tool

Fig. 5. Sleeve is placed inside the leaking tube

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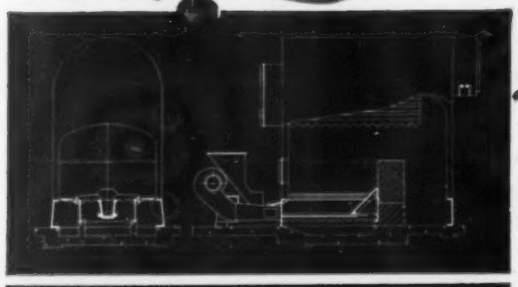

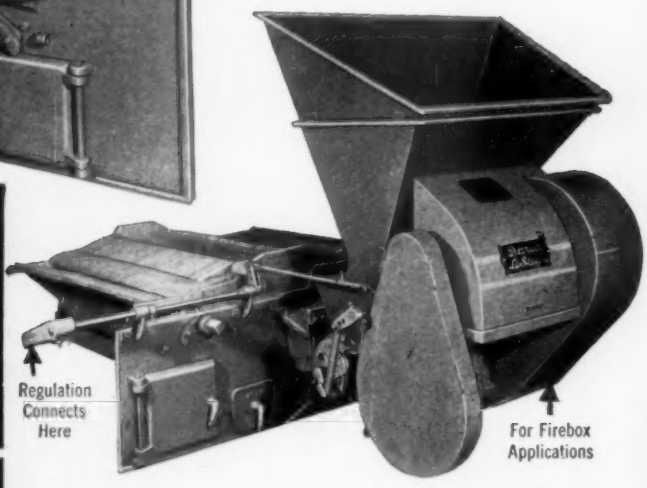

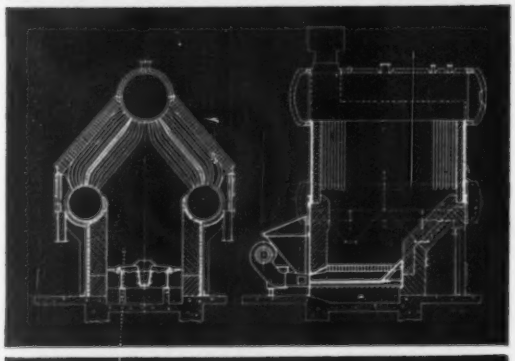

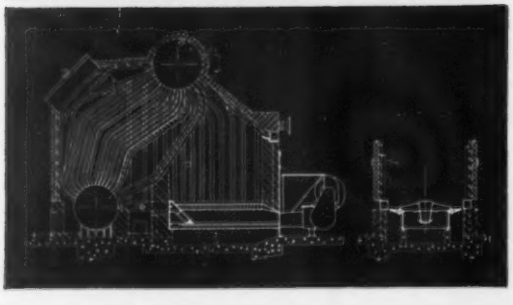

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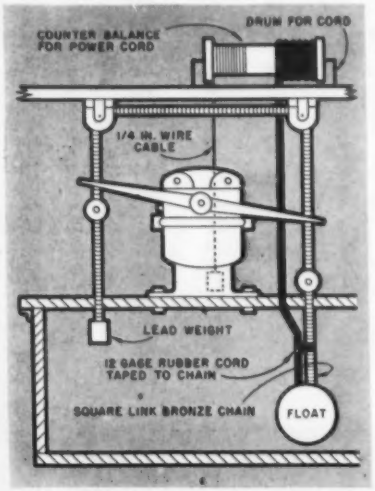
Freeze-Proofing a Float Switch Installation

BY PAUL C. ZIEMKE

NORTHERN climates can be troublesome in the frigid months. The underpass of a private logging railroad which dipped below the river bed level proved the point when difficulty developed in keeping the sag dewatered.



115-v, 550-w strap heater was installed in float

Failure of the pump to keep the seepage pumped down in the pumphouse sump resulted in many inches of ice forming over the rail level. Experiments with a salt water chamber in which was suspended the float of the electrically-operated pump were reasonably successful since it coincided well with the drain water outside. However, the corrosive nature of the saline solution soon raised havoc with the metals used.

Since the latent heat in the seepage water prevented too early freezing, it was decided to take advantage of this temperature differential between air and water by installing an electrically-heated float that would remain free of the slush ice that tended to form.

A 550-w, 115-v strap heater was torch heated and bent to conform to the interior diameter of the 12-in. copper float. A squeeze connector was used at the top to secure the two-conductor, No. 12 gage cord, which was further secured by taping it to the bronze chain.

A lead weight of sufficient size to counterbalance the cord was wound on the drum, spooling the cord up or down as the water level fluctuated. Since only a 4-ft differential of level occurred, the slack in the cord from drum to switch eliminated slip rings and brushes.

How to Prevent Freezing in Bare Steel Pipe

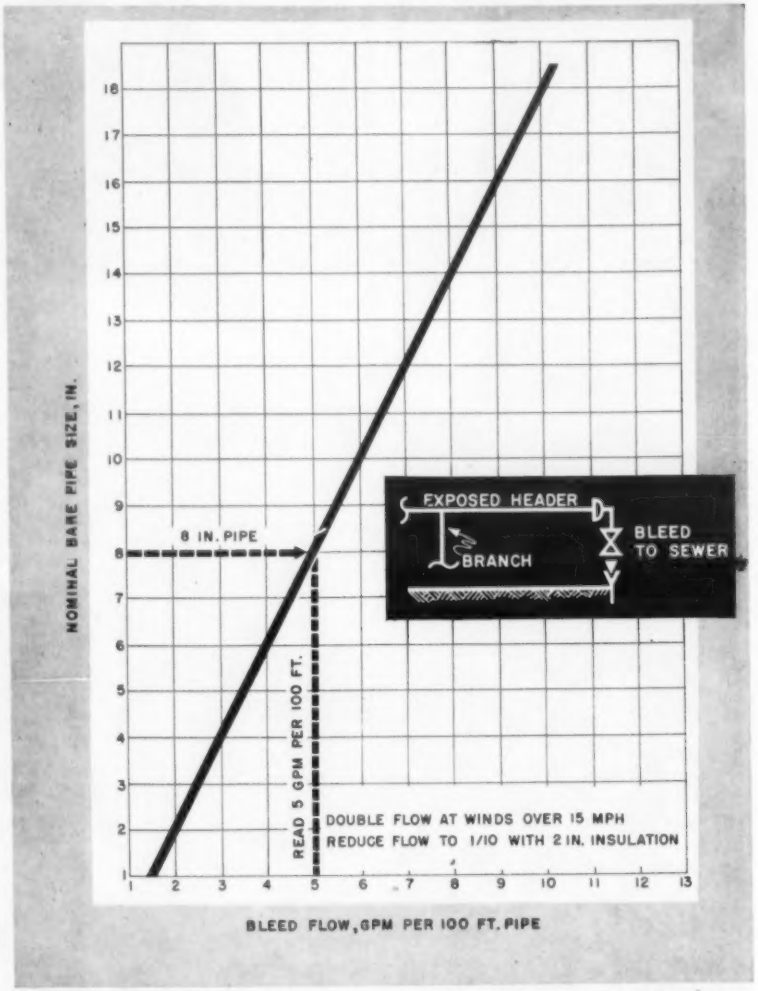
BY JOHN D. CONSTANCE

TO AVOID freeze-ups in unprotected water lines exposed to the weather, minimum water flows must be maintained. If such a line is a cooling water line or fire water line there is a minimum flow for each line size and length. Dead-ended water headers need such careful attention, for it is only a question of time until the contents freeze up when temperatures are below freezing. Insulation will not prevent freezing. Insulation retards heat flow. It does not eliminate it.

Graph shows bleed rates to avoid freeze-ups. Flows are per 100 ft of pipe of steel exposed to below-freezing (−20 F) and water at 40 F. If 2 in. of felt insulation and waterproofing are used, flow rates from chart may be reduced to one-tenth shown. Curve assumes steady flow pressures and normal (15 mph) wind velocities. If pressures fluctuate or winds are above normal, double flow rates. Pipe wall thickness or material have no perceptible effect on curve.

Example: An 8-in. dead-ended steel pipe carrying water is 250 ft long. It is exposed to the weather, lowest temperature −20 F, and the pipeline must be bled to prevent freeze-up, without using insulation or steam tracing. What is the bleed flow?

From curve read 5 gpm. Flow is then 2.50 × 5 or 12.5 gpm. If insulation is applied, flow is about 2 gpm. Excess wind velocities require a flow of 25 gpm.


NOMINAL BARE PIPE SIZE, IN.
8 IN. PIPE
READ 5 GPM PER 100 FT.
DOUBLE FLOW AT WINDS OVER 15 MPH
REDUCE FLOW TO 1/10 WITH 2 IN. INSULATION
BLEED FLOW, GPM PER 100 FT. PIPE
EXPOSED HEADER
BRANCH
BLEED TO SEWER

Minimum flow of water in bare steel pipe to prevent freezing, outside temperature −20 F, water temperature 40 F. This graph shows bleed rates to avoid freeze-ups. Flows are per 100 ft of exposed pipe

POWER ENGINEERING HANDBOOK

fold along this line—outside edges toward you

cut along this line

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EQUIPMENT NEWS

Reader Service Cards on pages 101–102 make it easy to get further information on any of these products. Just circle the item numbers of the products you want to know more about.

1—BRUSHLESS GENERATORS, a-c: 50, 60 and 400 cycles

These machines come in both single- and three-phase output with standard commercial voltages available throughout the range of sizes offered in brush type alternators. The 60-cycle, three-phase sizes extend from 5 to 400 kw, and 400 cycle from 1 to 250 kw, revolving field types in all standard commercial voltages through 600 v. Some sizes are available in higher voltages. These brushless generators are available in single-bearing and two-bearing close coupled design for direct connection to industrial engines and can be supplied in two-bearing design for belt drive applications.

There is no possibility of sparks with these brushless alternators, company points out, as spark producing components have been replaced with a system of rectifiers which change a portion of the a-c output to direct current, which is fed to the field poles of the exciter. The a-c output of the revolving armature type exciter is in turn fed to a rectifier assembly and changed to direct current which is fed to the revolving field poles of the alternator. In addition to increased safety factor and elimination of brush and ring maintenance, the size and weight of machines are less compared to the conventional type alternator, it is noted. Kato Engineering Co.

2—FLEXIBLE COUPLINGS are easy to install and align

These heavy duty flexible couplings come in sizes to 4250 hp and over. Connection to driving and driven shafts can be made in minutes, it is announced, and alignment is so simple it can be accomplished with a straight edge — gages are

not required. With bore sizes ranging to 9½ in., the couplings have bodies and jaws of machined electric steel or nodular cast iron. The load is entirely transmitted through compression of individual load cushions. This eliminates wear on the metal jaws, says manufacturer, and also permits reversal or advancing of cushions on non-reversing loads to double cushion life. Once installed, the couplings are said to require no lubrication and practically no maintenance. Cushions can be removed without disturbing driving or driven units. Lovejoy Flexible Co.

3—SAFETY HELMET re-designed for more protection

Dielectrically tested at 15,000 v for 1 min, the new Shockgard shows less than 8 milliamperes leakage, says manufacturer, and it withstands 40 ft-lb impact tests without losing any of its dielectric strength. The redesigned Shockgard is made of a plastic material in yellow and gray. It has no metal parts. Like the previous model, it is impervious to oil, grease and most chemicals, it is noted, and offers protection over a temperature range of −25 to 160 F. It is reported to meet all specifications under Schedule AP-1 established by the Edison Electric Institutes. The Shockgard's replaceable snap-in suspension allows for adjustment to fit different head sizes. Winter liners and chin straps are available. Bulletin 0607-2 gives details on the helmet. Mine Safety Appliances Co.

4—PROTECTED AISLE for use with outdoor switchgear

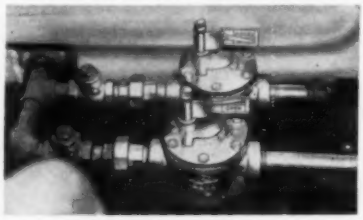
Available as optional equipment for use with company's outdoor Metal-clad Switchgear is a protected aisle. Furnished with equipments rated 2.4 to 13.8 kv with interrupting ratings of 75 to 1000 mva, the protected aisle incorporates major design improvements for applications where economy of installation and maintenance are preferred. One-piece construction of the protected aisle provides for quick installation at job sites. A reinforced steel floor, at the same elevation as the Metal-clad floor, is provided to allow breaker removal and servicing. Breaker can be passed side by side within the enclosure to eliminate need for a transfer truck. General Electric Co.

5—LOW PRICED CHLORINATOR for automatic proportioning

Model 70C1415 is announced as a pneumatic control chlorinator which automatically proportions chlorine flow to primary flow and costs substantially less than similar units. It uses a compact ratio relay assembly which may be mounted on the wall, or on top of the chlorinator. This assembly, which serves as a dosage adjustment, receives a 3–15 psig linear signal from the flow transmitter and transmits another 3–15 psig signal to the chlorinator's pneumatic rate valve. The output signal from the ratio relay unit is maintained at an adjustable preset ratio to the input signal. The chlorinator can be used also as the final control element in a residual chlorine control setup. Used thus, its pneumatic rate valve is operated by a 3–15 psig signal transmitted directly from a residual chlorine analyzer downstream from chlorinator. Fischer & Porter Co.

6—AUTOMATIC INDICATOR shows trap operation

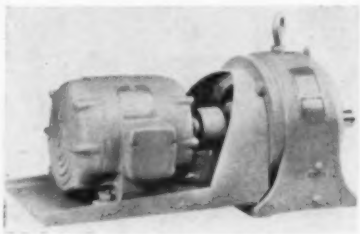
For use on Armstrong steam traps, the Trap-Indikator indicates trap operation at a glance. Of brass, aluminum and stainless steel, it is designed for maximum operating conditions of 250 lb at



450 F. When trap discharges, the flow of water moves an internal piston upward. Permanent magnet in piston moves trap indicator needle to show trap "open." When trap valve shuts, permanent magnet moves needle to indicate "closed" on face-plate. Proper trap operation is shown by intermittent face-plate readings of "open" and "closed." Hughes Machinery Co.

7—MOTORIZED DRIVES for use where downtime is critical

Line-A-Spede Drives are gear reducers powered by standard NEMA frame motors mounted on a shelf attached to the reducer. Double, triple and quadruple reduction gear units, with ratios up to 1487 to 1, are available for motor ratings of 1 to 75 hp. The unit is designed

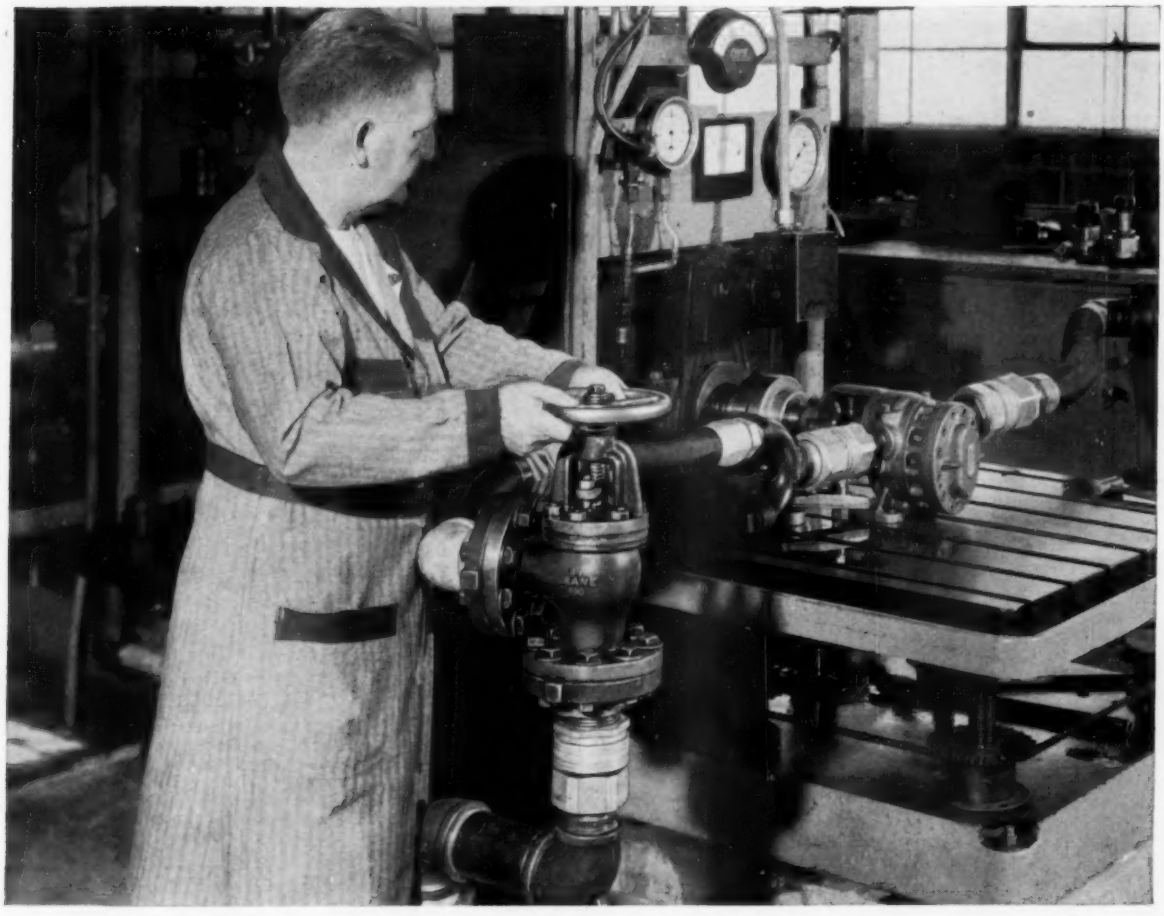


for installations where downtime is critical. Motors can be replaced rapidly by disconnecting the coupling between motor and reducer. In multi-unit gearmotor installations of similar rating, stand-by protection is afforded by one stand-by motor of the largest size required. Units are available for horizontal, vertical, flange, incline, sidewall or ceiling mounting. A backstop, to prevent reversed rotation, is an optional feature. The gear portion is also available separately without motor or shelf. Bulletin 2350 gives details. The Louis Allis Co.

8—GASKETING MATERIAL rubber asbestos, in two grades

Improved conformability and tighter sealing qualities with minimum flange loadings, also lower cost, are reported for Kaobestos. Gasketing for heat exchangers, compressors and diesel engines are among its applications. Kaobestos is available in two grades of

Roper Hydraulics, Inc. Experiences CRANE Quality



Uses CRANE valve on severe throttling for 23 years—without repairs

Twenty-three years ago, Roper Hydraulics, Inc., Rockford, Ill., installed this Crane 2½-inch, 300-pound bronze plug disc angle valve for throttling service on a 300- to 400-pound pump test line. Since then, testing has been done at pressures up to 1000 pounds without valve failure.

Altogether, this Crane valve has been operated intermittently on an average of 30 hours weekly for 23 years! Only recently was it necessary to replace some of its working parts. Here is demonstrated proof that Crane quality is really the durable kind purchasing agents seek . . . the dependable kind that engineers and plant operating people want.

In valves and fittings for every service, Crane quality gives greater assurance of value—it's today's most reliable price tag. And on all your piping equipment needs, you can get prompt delivery through your local Crane branch or wholesaler.

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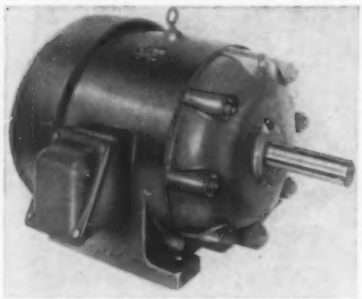
GRS, in Buna N and in Neoprene. Sheet sizes range up to 60 in. square; standard thicknesses from 0.015 to 0.125 in. Heavier thicknesses can be laminated. Die cut gaskets and sheet materials are available. F. D. Farnam Co.

9—TOUCH-UP LACQUER for control panel-boards

This spray-on touch-up lacquer is designed for preserving the appearance of control panel-boards and to reduce time spent n touching up panel-boards. The lacquer comes in both ASA 61 gray and No. 7 light green. Packaged in a 16-oz aerosol container, application is simple. Cost is under $5 per can. Panellit, Inc.

10—FIN-LESS MOTOR for use around explosive dusts

Absence of external cooling fins is said to make these motors particularly suited for use in dusty or dirty atmospheres of an explosive nature, where accumulation around fins would be dangerous. According to manufacturer, this motor series is UL approved for Class 1, Group D



(gasoline vapor), and Class 2, Groups F and G (explosive dusts) service in NEMA rerated frames 254U-256U, 284U-286U and 324U-326U.

The motors are housed in heat treated alloys of aluminum. Superior heat transfer characteristics of these alloys make possible an uncluttered frame, it is pointed out, and the aluminum alloy housing also provides lighter weight, increased tensile strength and greater corrosion resistance than possible with many designs. Electra Motors, Inc.

12—LIQUID LEVEL CONTROL for feedwater heaters

This pilot-operated liquid level control is designed to maintain desired level within 2 in.–1 in., plus or minus the setting. The control consists of exterior float, pneumatic pilot, and diaphragm motor valve. Slightest float movement causes the pilot to apply or release pressure on the diaphragm motor valve to open or close the feedwater inlet. By equalizing flow of water into the heater, this control helps solve three common problems. It is designed to prevent sudden and excessive demands for both water and steam, and to stop overloading of water treating equipment. At the same time, it provides greater uniformity in temperature and oxygen content of water sent to the boilers. The control is offered as optional control on manufacturer's feedwater heaters in capacities from 3000 to 300,000 lb per hour. Stickle Steam Specialties Co.

13—HIGH PRESSURE LUBE comes in unique package

Molylube 110-L is an extreme pressure lubricant packaged in a self-contained polyethylene oil can, described as shatterproof and reusable. A solvent refined petroleum oil containing a stable dispersion of molybdenum disulfide, Molylube 110-L is formualted to impart a tough film capable of withstanding shock load and wiping action. It displays high lubricity and polar affinity for metal surfaces greater than those displayed by regular mineral oils, according to manufacturer, and its high viscosity index assists in lubrication of bearing and machine parts at high temperatures. The compound is expected to find wide application in tightly fitted bearings, threads, sliding machine parts, heavily loaded bearings — wherever a fluid-type extreme pressure lubricant may be desirable to prevent seizing at bearing pressures. Bel-Ray Co., Inc.

14—CIRCULAR SLIDE RULE does simple calculations

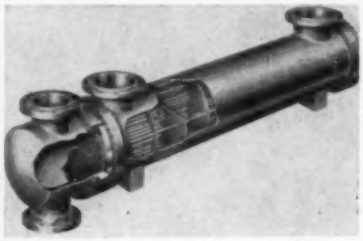
Operation of this pocket-size circular slide rule is claimed simple and the results accurate. To multiply, divide and find proportions is easy and fast, company states, and instructions are included. General Industrial Co.

15—GLOBE VALVE offers high corrosion resistance

Plug type globe valves with 500 Brinnell hardened stainless steel renewable seat and disc are announced for 150, 200 and 300 lb working steam pressure. Valve is suggested for service demanding extreme resistance to corrosive action on seat bearings such as is caused by throttling, wire draw, and foreign particles. It is claimed to afford maximum resistance to erosive service, where abrasion is present. Valve is available in sizes ¼ to 2 in. Hammond Brass Works.

16—HEAT EXCHANGER designed for process industries

Designated Type C-100, this pre-engineered, standardized line of exchangers offers extreme flexibility in materials, sizes and arrangement of components, mounting position, tube side passes, and nozzle orientation. Adaptable for use as



heaters, coolers, vaporizers or condensers, the exchangers can be built to handle any combination of liquids or gases. Featuring a floating head and removable bundle, they are available in one, two and four pass designs. Because of their versatility, they are also suited to general industrial applications. Ross Heat Exchanger Div. American-Standard.

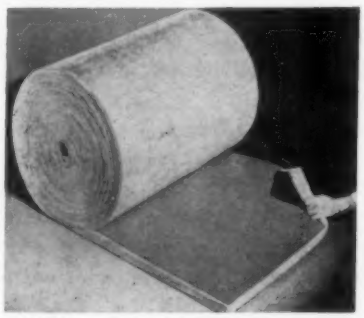
17—PLASTIC PACKING for use with high-speed shafts

Fluoropack is announced as a nongelling, putty-like packing material which is moldable under pressure to the contour of any stuffing box. It is designed for use on high-speed shafts as a seal which must retain corrosive liquids without leakage, heat build-up or shaft scoring. It is self-lubricating, requiring no external lubrication. Fluoropack is composed of finely divided Teflon compounded with a blend of fractions of Halocarbon polychlorotrifluoroethylene oil. Manufacturer explains that while it contains a large proportion of the chemically inert oil, the packing will not bleed except under elevated temperatures and pressures. Its normal service temperature range is given as −40 to 350 F, with application up to 450 F where pressures are low. Due to its plastic characteristic, it should be confined in the stuffing box by solid end-rings of Teflon. Halocarbon Products Corp.

11—GLASS FIBER LINER for air conditioning, heating ducts

Described as exceptionally light weight, Therma-K Duct Liner is for air conditioning and heating applications where temperatures range from sub-zero to 350 F. This liner offers low air resistance, manufacturer states, making it suited for all heating or cooling ducts, especially those carrying air at high velocities; it provides low thermal conductivity, noise reduction and long life.

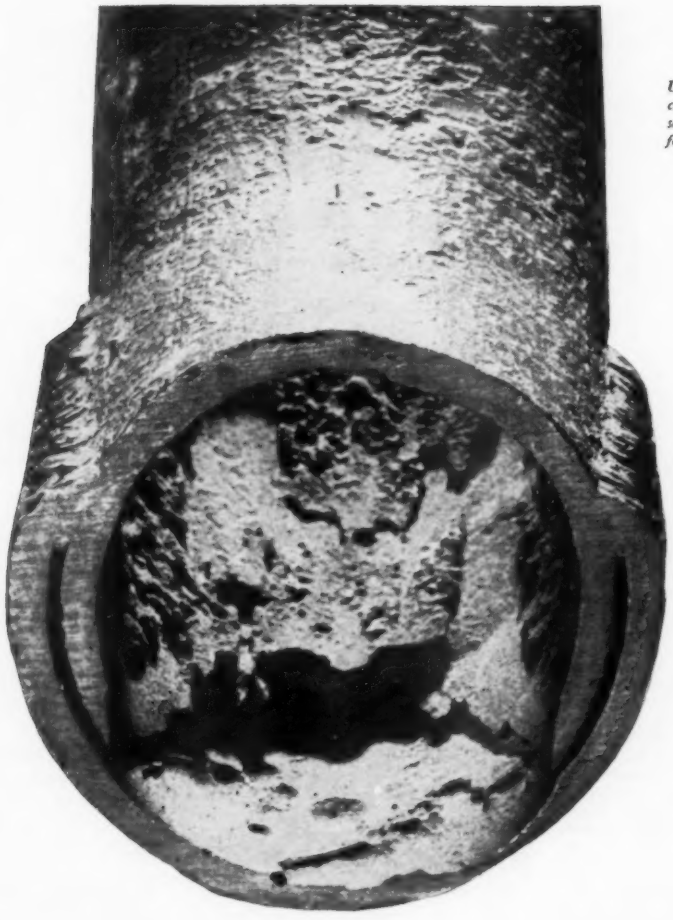
Therma-K Duct Liner is shipped in compression-packed rolls. As it is unrolled, the insulation springs back to original thickness. The side exposed to hot or cold air flow is coated with black pigmented vinyl or Neoprene plastic to minimize air resistance. According to manufacturer, this liner is easily cut and cemented to the unformed sheet metal and, as the duct is formed, bends to shape, without breaking or weakening. No vapor barrier is required because the



duct liner stops cold from reaching the inside surface of the duct, it is pointed out, and this prevents water vapor from condensing on the outside surfaces. It comes in 36- and 48-in. widths, 50- and 100-ft rolls, in three densities. Ehret Magnesia Mfg. Co.

18—DEHYDRATION UNIT is compact and low in cost

This dehydration unit is claimed to make possible, economically, dew points of −150 F and 5-micron filtration of air, gas or liquids. According to manufacturer, these dehydrators will remove 1 lb of water for as little as 7 cents, where the former cost ranged from $2.50 to



Unretouched photo of pipe, corroded by carbonic acid, which has been "half-soled." This was only a temporary cure, for now the patch is also being eaten away.

WHAT DO YOU PAY FOR "HALF-SOLED" PIPE?

Plenty—in expensive maintenance and costly down time. This pipe has been "half-soled" by welding a metal half-circle over the corroded section—a temporary measure at best. But the original cost has been lost, for now the patch is also being eaten away. You can save money by preventing damage like this with proper water treatment.

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$3.75. Also, these dehydrators range in size from 2 to 8 in. in diameter, much smaller than many designed for comparable service.

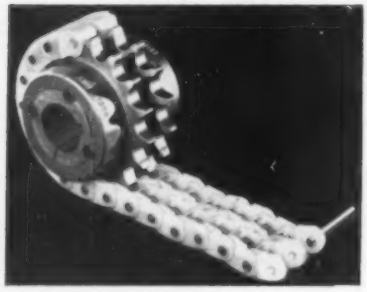
Key to this dehydrator's success in obtaining low points is its compensating cartridges, says company. The water-soluble chemical desiccant in the cartridge is under constant spring compression, it is explained, and as this chemical dissipates on water contact, the spring adjusts toward the point of contact, eliminating voids and fissures. Low initial and installation costs as well as low maintenance cost are reported to make this unit an economically feasible solution to the problem of the elimination of freezing and corroding in air-operated equipment such as control valves, gas engines on package process units, orifice meters etc. The unit is also suggested for plant air systems, process streams and for air compressors. Dehydrators, Inc.

19—PUSHBUTTON SWITCHES are modular-mount type

Series 100PB are modular-mount lighted pushbutton switches designed for easy mounting and uniform, modern appearance. Switch assemblies are available in three models — a light-force, a positive touch-feedback and an alternate-action design. Two-, three- and four-pole switching assemblies are available in the light-force and positive touch-feedback designs. Two-pole double-throw circuitry is provided in the alternate-action switch. Switches mount end-to-end in rectangular slots, length of slots depending upon number of switches used. Pushbuttons are available in several colors and color combinations. All switches use company's Type SM sub-miniature basic switch. Each is a single-pole double-throw unit of high capacity for its size, rated at 5 amp, 125 or 250 v a-c, 3 amp inductive and 5 amp resistive, 30 v d-c, 24 amp maximum inrush, 30 v d-c. Micro Switch, Div., Minneapolis-Honeywell Regulator Co.

20—FLEXIBLE COUPLINGS, of lubrication-free nylon

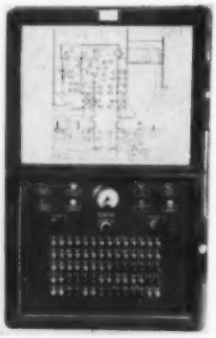
Completely corrosion-resistant, the chain element of these couplings is constructed of nylon segments and stainless steel pins. It can be disassembled or connected at any link without special tools, and fits standard, stock steel roller chain



sprockets. The coupling (shown before assembly) needs no protective cover, company states, handles loads from fractional to 40 hp and speeds from 500 to 5000 rpm. According to company, complete couplings (½ in. pitch links and soft steel sprocket) or chain elements are available, at a cost of about 20 per cent less than comparable all-steel couplings. Morse Chain Co.

21—SOOT BLOWER SYSTEM gives every-step control

Finger-tip control of every step in the soot-blowing system is claimed for the Vulcan Automatic-Sequential System. You can pre-select, through individual toggle switches, any number of soot blowers to be operated through automatic sequence and pre-select any number of units to be operated individually



for optimum boiler cleanliness. The new "package" system also is designed to permit reversing any retractable blower at any point in its cycle, switching instantly from automatic sequential to single-unit operation and providing warning in case of a malfunction. The controller is set in operation by closing a master switch, and the sequence is continued until all soot blowers switched in are put through their cycles. The sequence can be stopped and restarted at any point. The electrical circuit is an electro-controller type using a rotary stepping switch and plug-in control relays with a program light on the master panel for each blower. The controller is a self-contained unit with all parts mounted in a case. Three models are available. The EC-120 will place up to 120 soot blowers in automatic sequence. The EC-60 handles up to 60 blowers; and the EC-45 is for 45 and fewer blowers, and where no boiler cross-section diagram is required on the panel face. These controllers are applicable with air or steam or a combination as the blowing medium, but only for systems using electric drive, manufacturer states. Copes-Vulcan Div., Blaw-Knox Co.

22—INDUSTRIAL THERMOMETER for many applications

The BX series of industrial thermometers is designed for plumbing, heating, ventilating, piping, air conditioning and refrigeration installations. Cases are cast aluminum, with stainless steel front, white scale with black numbers and red-appearing mercury tube. Thermometer is available in nine standard temperature ranges from −40 to 1000 F. Five optional straight or angle mounting forms are for pipe (with or without insulation), and air ducts. H. O. Trerice Co.

23—SYNCHRONOUS GENERATOR offers design improvements

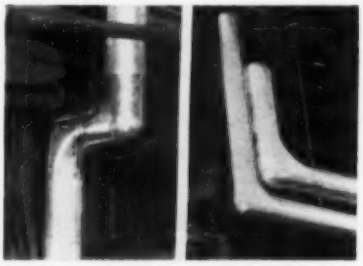
Redesigned high-speed synchronous generators in single bearing units for internal combustion engines, close-coupled to standard SAE flanges, or in two-bearing units for belt drive or direct connection are announced in ratings from 30 through 150 kw at 1800 rpm and 50 through 300 kw at 1200 rpm. The generators feature an improved exciter located inboard of the bearing to provide a shorter, lighter, more compact machine. They have oversize grease-lubricated ball bearings, and a rigid rolled steel yoke and cast iron housings provide a solid bearing support. The generators' 12 leads permit a wide choice of voltages, and an extra-large conduit box provides space for making connections. The generators are available with Class A or B insulation, or with special insulation materials. Allis-Chalmers Mfg. Co.

24—GLOBE VALVE for process piping, power application

Said to overcome the problems of increasing temperatures, pressures and corrosion, the Fig. F80 has a forged steel body, bonnet and two-piece gland for maximum strength and high safety factor. Flexitallic gaskets, which are generally reuseable, are utilized to afford a tight seal for the bolted bonnet. The valve's stem is stainless steel. Molded asbestos packing, mica lubricated and wire reinforced, serves to reduce stem corrosion and electrolytic action. These globe valves are fabricated in eight sizes from ¼ to 2 in. with handwheel diameters of 3½ to 6 in. Manufacturer says the Fig. F80 is subjected to hydrostatic shell test pressures of 2500 psi and an air under water test of 100 psi. R-P&C Valve Div., American Chain & Cable Co., Inc.

25—JACKETING ELBOW, of aluminum, has oversized hump

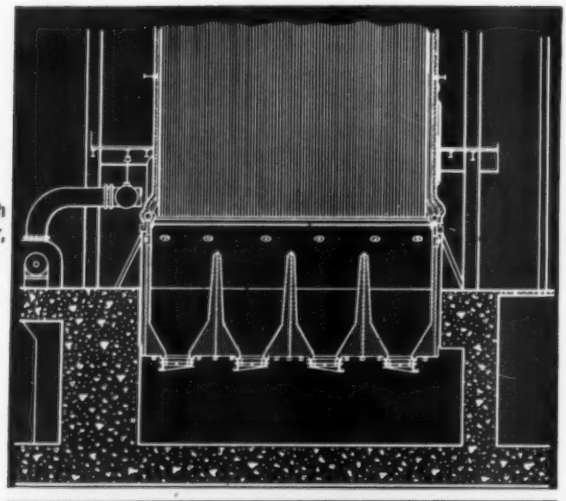
Secret of this aluminum jacketing elbow, called the Gasco Humped Aluminum Elbow, is the oversized radius or "hump" that enables use over several pipe and



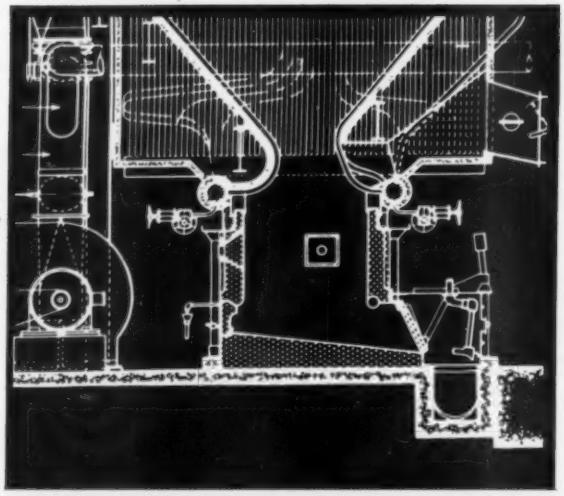
insulation sizes and allows it to fit long and short radius "ells." Twelve interchangeable sizes of humped ells fit over 107 combinations of varying pipe sizes and insulation thicknesses. Made of heavy gage aluminum, there are no metal folds, giving a smooth, wrinkle-free appearance. Covers are supplied in two halves which nest together and take up little storage. They are installed with sheet metal screws and may be removed for inspection. Pittsburgh Corning Corp.

26—REMOTE VALVE CONTROLS designed for nuclear reactors

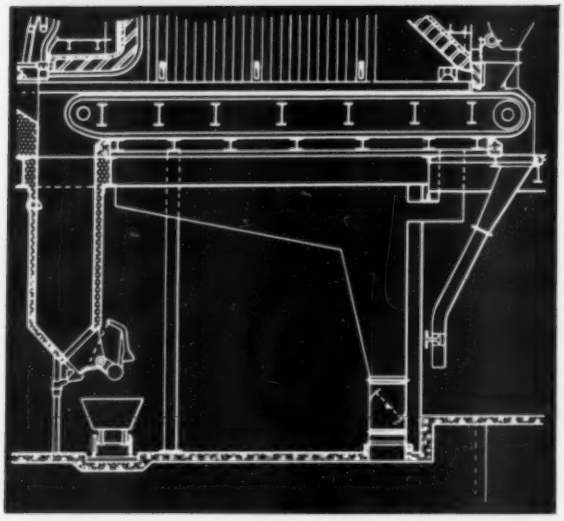
Manufacturer of these manual remote controls explains that in nuclear power plants, various valves in contaminated areas must be controlled from outside the heavily insulated area. Often 4- to 6-ft concrete walls are used. This radioactive protection is chiefly against gamma rays, which travel in a straight line from point of origin until stopped by some insulating or other device. These



Erosion, due to dry ash sliding down the hopper, is the big problem in this ashpit.



Water jets can cause abrasion of ashpit floor refractories, and water splattered on the walls may cause spalling.



Continuous deposits of ash from a stoker-fired boiler have an abrasive effect on this ashpit lining.

Reduce refractory wear in ashpits with B&W Kaocrete

Relining ashpits is expensive. That's why power engineers specify heavy-duty B&W Kaocrete-D. On job after job, in all types of ashpits, this refractory castable has withstood the heavy abrasive and erosive attacks of sprays, jets, rakes and shovels.

The reason? Specially designed B&W Kaocrete-D has the strength and hardness needed for tough ashpit service. It has unusually high resistance to abrasion, erosion and spalling. It also saves time because it can be cast or gunned in place.

For the facts and figures on Kaocrete-D, as well as Kaocrete-A which is recommended for less severe applications, consult your local B&W Refractories Engineer.

Send for Bulletin R-40 which gives data on B&W Kaocrete Refractory Castables for lining ashpits.

R605

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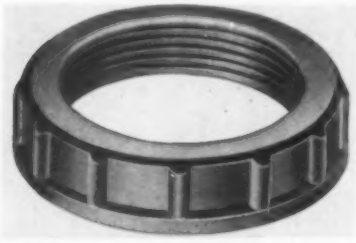
For more data circle 542 on Post Card

flexible shaft valve controls are designed to function through these walls in irregular curves around which it is impossible for gamma rays to travel.

The controls include flexible shafts in sizes from ½ to 1⅝ in. in diameter. They have asbestos packing in place of O-rings, and a non-organic lubricant to prevent damage by radiation. Company also furnishes valve couplings and remote operating stations. Valves can be controlled in sizes up to those with 27-in. diam handwheels. Because of the torsional deflection in flexible shaftings in long lengths, this is not suited for operating metering valves, manufacturer notes, but in such cases a combination of reach rod controls and flexible shafting can be used. Stow Mfg. Co.

27—INSULATING BUSHINGS are of ribbed design

For use with Sherarduct and other types of rigid electrical conduit, these black butyrate insulating bushings are of ribbed design and engineered to with-



stand heavy impact. Deep threads permit high torque pressures without stripping, it is pointed out, while an extra-heavy bottom flange provides added strength. Another feature includes 12 raised ribs for easy finger tightening and final screw or channel lock setting. Bushings come in 12 sizes from ½ to 6 in. National Electric Products Corp.

Described on these pages are new and improved products. Use Reader Service Cards on pages 101–102 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

28—MOTOR DRIVE for use in corrosive atmospheres

For use where corrosive atmospheres present an operating problem, the corrosion-proof Vari-Speed Motodrive is claimed to resist most acids, gases and corrosive dusts. It is designed to give infinitely variable speed over a wide speed range, with just a turn of a handwheel, and to withstand rugged service. "Close grooving" lubrication serves to eliminate possibility of sticking discs in corrosive atmospheres, even with long intervals of time between speed changes. Used on both constant and variable-speed disc assemblies, it distributes lubricant into fine grooves in the hub bore of the sliding disc, and coats the sliding contact surface.

The entire Motodrive case, of cast iron, is impervious to most corrosive conditions, manufacturer states, and effective sealing of the case-openings excludes corrosion causing materials from internal operating parts. Exposed cap screws are hex-head and zinc coated. The drive motor is corrosion-proof with cast iron used in the frame ring, end bracket, outer fan and fan cover construction. Corrosion-resistant construction is also announced for the gear reducer, conduit box; stainless steel is used for nameplates. Bulletin M-578 gives data. Reeves Pulley Co., Div., Reliance Electric & Engineering Co.

30—CROSSBAR SCANNER is high speed instrument

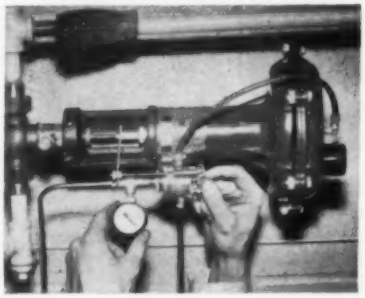
Model SC2 is designed for scanning 500 pairs of input connections at a rate of 50 pairs per second, bringing the selected pair to a set of output terminals. Properties of the Model SC2 suggest its use for scanning thermocouple voltages, strain gage voltages, analog computer outputs, and applications where a high quality contact, together with high scanning speed are paramount considerations. This scanner is designed around manufacturer's Type F crossbar switch. To satisfy the speed requirement, a type of logic combining advantages of electronic circuitry with those of the crossbar switch has been incorporated. This combination is claimed to result in a high-speed scanner of longer life than rotary sampling switches and higher speed than stepping-switch scanners. Contact characteristics of the crossbar switches are reported such that low-level signals impressed on this canner will be reproduced faithfully.

While this scanner is designed to operate at 50 pulses per second, with a minimum dwell time of 5 milliseconds, at each selected pair of points, both higher and lower repetition rates are possible. In addition to the selected pair, and "end of scan" indication is provided. Consisting of three separate units, the scanner is made to mount on Grant No. 350 slides in a 19-in. width rack. James Cunningham, Son & Co., Inc.

31—PNEUMATIC RELAY installs with screwdriver, wrench

The Sta-Put is an adjustable positioning relay for control of pneumatic motors and valves. A screwdriver and wrench are all you need to install it. The Sta-Put is designed to counteract effects of friction and load factors which prevent a pneumatic motor or valve from responding properly. It assures specified performance of new equipment by compensating for extraneous factors, company says, and it can also be used to tune up sluggish existing motors and valves, or adapt them to increased load conditions.

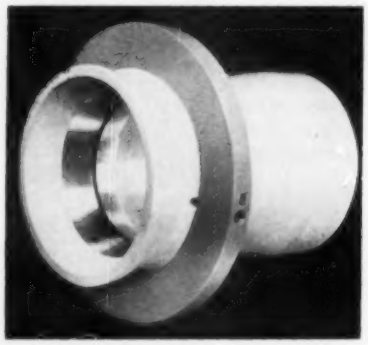
Smaller than previous models, the



relay attaches directly to the controlled motor or valve. An adjusting screw on the relay can be set to delay operation of motor or valve until control pressure reaches a desired point between 2 and 15 psi. Distance of motor or valve stem travel for various changes of control pressure can be adjusted between 2 and 13 psi. The Sta-Put can be fitted to 3-, 4- and 6-in., pneumatic motors, and to 8- and 12-in. diaphragm valves. One relay can handle multiple installations of four 6-in. or ten 4-in. motors. Normal air supply pressure recommended for the Sta-Put is 20 psi, maximum air pressure is 25 psi. Reliable performance is reported from 20 to 180 F. The Powers Regulator Co.

32—FLOW TUBE designed for metering the problem fluids

Model DFT-PI is a compact, plastic, insert-type Dall flow tube for low-cost metering of problem fluids. It is made of epoxy or polyester resins, reinforced with fiber glass, with corrosion-resistant metallic throat-ring and flange. This flexible differential producer is said to be ideally suited for metering ordinary liquids, gases, and even acids, alkalis, and slurries, with low head loss and consequent reduced pumping cost. It



fits between pipe flanges, and its short length and light weight make it easy to install. Accuracy is reported within ±1 per cent of actual flow rate for uncalibrated units, ± ½ per cent by laboratory calibration. Standard models are available with a variety of metallic materials, and for pH from 0.2 to 10. Temperature ranges are from −60 to 220 F. Builders-Providence, Inc., B-I-F Industries, Inc.

33—ANCHOR CEMENT offers improved performance features

Addition of a new chemical element is said to have greatly improved Evr-Tite, a fast-setting pourable cement for speedy bolt anchoring. Evr-Tite is claimed to possess new setting hardness, abrasion resistance and shock absorbing characteristics which enable it to withstand severe vibration of heavy machinery. Tests are reported to show that its strength has been rasied to 10 times that of many powder or holding cements while the expansion factor has remained comparable.

Supplied as light grey powder, Evr-Tite mixes with water to form a semi-fluid, pourable compound. Applied around an anchor bolt, it attaches itself to the bolt surface, filling all sections of the hole to produce a void-free monolithic anchor. According to manufacturer, the cement sets in 10 min; bolts can be drawn tight and machinery put

in operation within a half hour, and heavy vibrating equipment can begin operation within an hour. Evr-Tite can be hand or machine mixed, and there is claimed to be no flash-set with machine mixing. Other applications for the cement include fastening and setting of pipe flanges, and repairing of shallow holes in concrete floors. The Monroe Co., Inc.

34—FLEXIBLE DRIVE COUPLING installs with Allen wrench

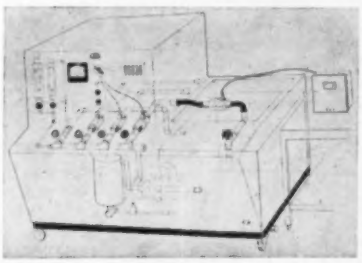
Magnaloy Flexible Drive Couplings are made of a magnesium alloy reported to provide the strength of steel with an 80 per cent reduction in weight. Low weight is valuable in minimizing vibration, it is pointed out. Installation of these couplings is simplified as they are not pressed

on, but slipped over the shafts. They are made tight through the use of separate split hubs, which fit into the coupling halves, like a tapered tool shank in a holder. Socket-head screws are used to draw the two together and this compresses the split hub around the shaft.

Removal is accomplished by inserting the same screws in holes drilled only in the hub. The screw meeting the opposing face of the coupling forces separation of the two. All hubs, regardless of bore size, are interchangeable in the couplings of each model size, and both halves of the coupling are identical. The drive is transmitted through a lugged Neoprene drive insert. Couplings are made in eight size steps, and will accept ¾- to 6-in. shafts. Detroit Power Coupling Co.

35—CALIBRATION STAND is comparison type unit

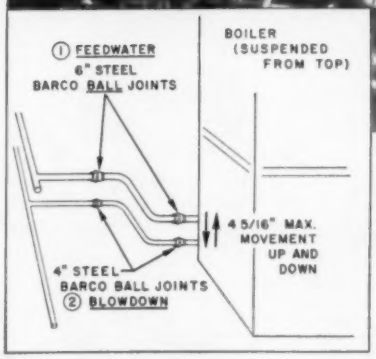
This packaged portable unit for calibrating liquid flowmeters — a comparison type calibration stand — uses turbine flowmeters as calibrating standard. The stand uses water, hydrocarbons and/or



oils as its calibrating medium and is claimed accurate to 0.5 per cent of instantaneous flow rate. Range is from 0.5 to 150 gpm. For calibrating all types of flowmeters, including variable area, turbine, positive displacement and orifice meters, the basic design is flexible to permit tailoring to individual requirements. Accessories, such as temperature, viscosity and density indicators; heating or cooling coils; filters; counters; and explosion-proof construction are available. Fischer & Porter Co.

more Equipment News page 111

. . . where BOILERS move UP and DOWN



BARCO Ball Joints

The schematic diagram at left shows how Barco Flexible Ball Joints of steel construction are used in a new Florida utility plant—design pressure 600 psi, 500°F. The above photo shows a close-up view of two of the joints (see arrows). Two more matching joints, 4" and 6", are located out of the picture to the left. The 4" joints have metal gaskets. The same utility also uses 10" Barco joints on gas fuel lines. Other uses in power plants are for flexible connecting lines to oil burners, soot blowers, and other auxiliary equipment.

Flexible Pipe Connections!

The rapidly increasing use of Barco Flexible Ball Joints for solving piping problems in POWER PLANTS is significant for several key reasons:

1. Substantial *space saving* as compared to other methods in crowded piping areas.
2. Unlimited flexibility and movement. Utmost simplicity.
3. No heavy pipe anchoring required. No "end thrust" developed under pressure.
4. Ability to handle compound movement (where twisting is combined with thermal expansion and contraction).
5. Easy to engineer joints into piping to provide for any degree of flexibility, expansion, or movement required.
6. Maximum safety for high temperature applications. All-metal construction available. Special alloys can be specified.
7. Basic design is pressure sealing against leakage and self-adjusting for wear.
8. Virtually no deterioration. Able to stay in service for years without repairs or maintenance. No lubrication.

New Bulletin No. 31 contains interesting diagrams showing how to solve many common pipe expansion problems EASILY, ECONOMICALLY. *Ask for a copy;* see your nearest Barco representative or write:

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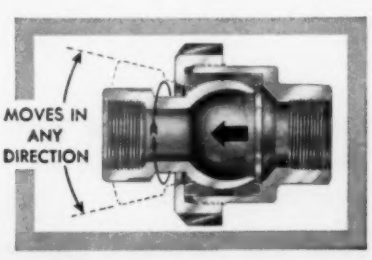

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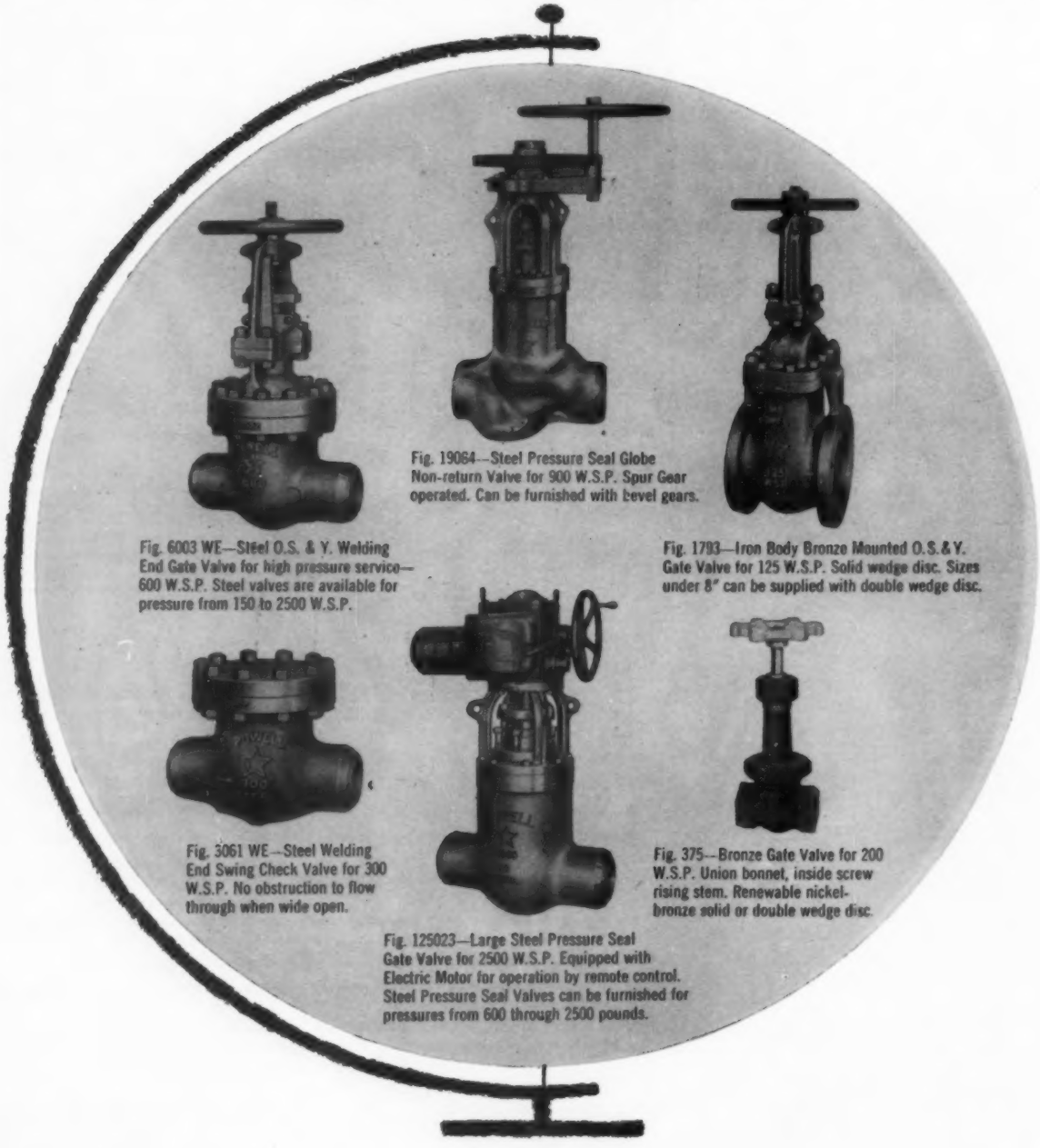

Fig. 19084—Steel Pressure Seal Globe Non-return Valve for 900 W.S.P. Spur Gear operated. Can be furnished with bevel gears.

Fig. 6003 WE—Steel O.S. & Y. Welding End Gate Valve for high pressure service—600 W.S.P. Steel valves are available for pressure from 150 to 2500 W.S.P.

Fig. 1793—Iron Body Bronze Mounted O.S.&Y. Gate Valve for 125 W.S.P. Solid wedge disc. Sizes under 8" can be supplied with double wedge disc.

Fig. 3061 WE—Steel Welding End Swing Check Valve for 300 W.S.P. No obstruction to flow through when wide open.

Fig. 375—Bronze Gate Valve for 200 W.S.P. Union bonnet, inside screw rising stem. Renewable nickel-bronze solid or double wedge disc.

Fig. 125023—Large Steel Pressure Seal Gate Valve for 2500 W.S.P. Equipped with Electric Motor for operation by remote control. Steel Pressure Seal Valves can be furnished for pressures from 600 through 2500 pounds.

FOR EVERY FLOW CONTROL PROBLEM Powell offers more kinds or types of valves, available in the largest variety of metals and alloys, to handle every flow control requirement. Your local valve distributor will be glad to tell you all about them. Or write to us for the full facts.

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INSTRUMENTS, CONTROLS

201 Meters and Controls — Over 100 measuring, transmitting, receiving, recording and indicating instruments and control components, including those introduced within the last year, are described in the 8-pp 1957 edition of company's Bulletin G15-1. Applications, ranges, and detailed literature references are given for each product. Bailey Meter Co.

202 Guide to Gages — Catalog 300-B, 112 pp, features Ashcroft Duragauges, Maxisafe, pneumatic receiver, recording, quality, drawn casem chemical and special application gages. Also presented are gage testers, pneumatic transmitters, gages for nuclear energy. Engineering data and charts are provided. Instruments shown cover dial sizes from 2 through 24 in., pressures from 30 in. vacuum or a few ounces up to 100,000 psi. Manning, Maxwell & Moore, Inc.

203 Bi-Color Gage — Bulletin 1174 describes advantages of company's multiport bi-color gage made for medium and high pressure ranges. A cutaway view illustrating component features is included, as well as drawings and photos showing installation methods. Diamond Power Specialty Corp.

204 Electric Indicating Temp Controls — Bulletin 1025 describes operation and advantages of company's electric indicating temperature controls. Includes dimensional data, wiring diagrams, and typical control combinations, as well as other information. Sarco Co., Inc.

ELECTRICAL EQUIPMENT

205 Testing Instruments — Bulletin 19-58, 16 pp, features company's electrical testing instruments, including ohmmeters, ground testers, dielectric test sets, motor rotation tester, cable fault locating equipment, transformer turn ratio test sets, corona test equipment, frequency meters, tachometers, others. Includes photos and descriptions of each type, covering chief features, operating ranges, and applications. James G. Biddle Co.

206 Handbook on Fuses — This 12-pp booklet contains practical information on how to get safe, dependable, trouble-free electrical protection. Shows what to do when fuses blow, how to determine cause of blows, what kinds of fuse to use for various circuits. Contains short history of fuses and notes on construction of fuses, as well as volt loss tables. Bussman Mfg. Div., McGraw-Edison Co.

207 Electrical Enclosures — Bulletin EE, 14 pp, describes company's line of sheet metal electrical enclosures and other related items for a variety of applications. Covers control desks, electrical cabinets

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and enclosures, power distribution and control panels, boiler, turbine, generator control panels, switchgear housings, instrument panels and others. The Kirk & Blum Mfg. Co.

208 Integral Distribution Center — Bulletin GEA-6619, 16 pp, contains complete data on company's dry-type integral distribution center for such applications as industrial plants and warehouses, office and commercial buildings, and others. Tells how one-piece construction saves space, simplifies specifying, ordering, and installation. Model numbers, dimensions, and choice of incoming line components are given. General Electric Co.

209 Battery Service Tips — Latest information on industrial batteries on cycle service is provided in the new edition, about 40 pp, of company's industrial battery service manual. Includes photos, charts, tables, repair methods, maintenance, and salient points on operation, instructions covering repairs with regular or special tools. Also covered are simplified testing methods (including safety practices and acid-handling precautions), and instruction on correct charging methods. C & D Batteries, Inc.

BOILERS, GENERATORS

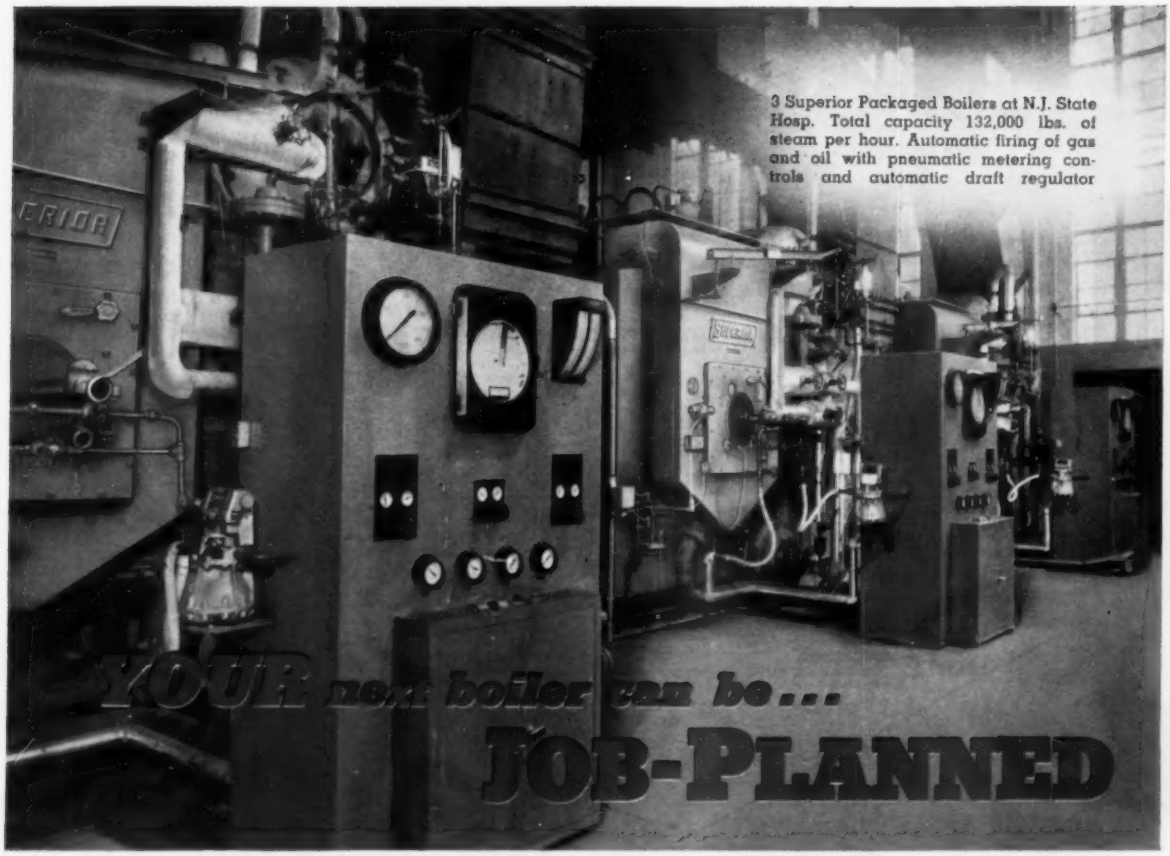
211 Boiler Control System — Bulletin 1038, 12 pp, describes complete boiler control systems available for large utility power stations. Using a 900,000-lb-per-hr installation as an example, it gives a detailed description of each component, combustion, fuel cutback, pulverizer temperature, feedwater, and feed pump recirculation controls, as well as automatic-sequential soot blowing system. Schematic diagrams of systems are included. Copes-Vulcan Div., Blaw-Knox Co.

212 Package Boilers — This 12-pp booklet on package steam generators describes the formulas behind all package steam generators, and illustrates how installation of a package steam generator can raise steam capacity in an existing boiler room without extensive structural changes. Cyclotherm Div., National-U. S. Radiator Corp.

213 Fire Tube Boilers — This 12-pp catalog describes Superior Compact packaged boilers in capacities from 20 to 200 bhp. Interesting arrangement of text, illustration and color is used to explain many features of the units. Gives complete data and dimensions for boilers designed for firing oil or gas or both. Superior Combustion Industries, Inc.

214 Packaged Steam Generator — Advantages of company's baffleless, pressurized two-drum water tube packaged unit are detailed in 12-pp Catalog SB-59. Features of the completely integrated generating plant, which requires no field piping, wiring, brickwork or special foundation, are shown on cutaway illustration. Erie City Iron Works.

215 Steam Generators — Twelve-pp Bulletin PSG-2 contains design and construction details on company's package unit steam generator — a vertical, bent tube, longitudinally fired water tube boiler. Capacities, dimensions and weights are tabulated and drawings, diagrams and photos showing fabricating methods included. Henry Vogt Machine Co.


3 Superior Packaged Boilers at N.J. State Hosp. Total capacity 132,000 lbs. of steam per hour. Automatic firing of gas and oil with pneumatic metering controls and automatic draft regulator
YOUR next boiler can be...
JOB-PLANNED

and FACTORY-FIRE-TESTED . . . Too!

Flexibility of choice with a complete "Superior Guaranteed Package"

Capacities to 50,000 lbs. per hour.
Design pressure to 900 p.s.i.g.
Fully or semi-automatic operation.
Integrated console or free-standing panel.
Electric or pneumatic metering combustion controls.
Electric position (parallel) combustion controls.
Rotary cup burner to 27,000 lbs. per hour.
Single or multiple steam atomizing burners.
Single or twin element feedwater regulator
Steam or air puff soot blowers.
Low and high duty superheaters.
Separate packaged economizers.

All this with undivided responsibility, guaranteed performance and efficiency for minimum maintenance.

Why not choose your "guaranteed" packaged boiler to meet the needs of your job, just as you would when specifying a field-erected plant, and still get the advantages of factory assembly, factory-fire-testing, and most important, undivided responsibility?

The Superior Packaged Boilers pictured here are "job-planned" units incorporating burner and control equipment as specified by the purchaser, and tested at actual working conditions before shipment.

Testing involves all functional equipment: forced draft fan, burner, combustion controls, programming equipment, etc., mounted or connected to the boiler, thus providing a guaranteed product with undivided responsibility. Why settle for less? Why purchase half a package? For details write for Catalog 1006-W.

Specialists in PACKAGED BOILERS . . . exclusively

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TIMES TOWER, TIMES SQUARE, NEW YORK 36, N.Y.

SUPERIOR
PACKAGED BOILERS

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Costs Less...

No Maintenance!

Flexon®

HIGH-PRESSURE, HEAVY-DUTY EXPANSION COMPENSATOR

Inch for inch, the lowest-cost way to take care of pipe motion

Never needs maintenance, because it's completely packless

Heliarc welded construction... and steel-encased for protection from external damage

Its 2-ply stainless steel Flexon bellows is designed to outlast the building

INSTALL IT... FORGET IT!

You can bank on it . . . Flexon Model H Expansion Compensators cost much less per inch of stroke than *any other method* of absorbing pipe expansion! Yet the Model H is built for hard service, with its 2-ply stainless steel Flexon bellows, positive internal guide and anti-torque device, and full protection from external damage.

This is why engineers and piping contractors are specifying the Model H for thousands of industrial piping jobs—in heating systems, process piping, steam tracing, power piping—that use pipe up to 3" and require up to 2" total movement at each Expansion Compensator. Working pressures to 175 p.s.i. for ¾" and 1" sizes; to 125 p.s.i. for larger sizes up to 3".

Make the Flexon Model H Expansion Compensator a cost-cutting part of your next piping job. Write for design and cost data, and the name of your Flexon representative.

EC-120

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EXPANSION JOINT DIVISION • 1374 S. THIRD AVENUE, MAYWOOD, ILLINOIS

EXPANSION JOINTS · METAL HOSE · NON-METALLIC HOSE · BELLOWS · AIRCRAFT COMPONENTS

216 Standard Generators — Bulletin B-55-4 describes company's SC economy series of standard steam generators designed to reduce steam costs for industrial plants. Pre-engineered, standardized steam generators offered in nine sizes, with capacities of from 50,000 to 150,000 lb per hour are described, and schematic and cutaway drawings of design features are included. Foster Wheeler Corp.

TUBING AND ACCESSORIES

217 Heat Exchanger Tubing — Cited in this 30-pp catalog are typical cases where cupro-nickel or Monel tubing installed in heat exchangers resulted in substantial savings and better efficiency through longer tube life. Describes applications of this tubing in various instances where unusual water conditions, as to pollution, excessive turbulence, temperature and the like, required such tubing. The International Nickel Co., Inc.

218 Tube Expanders, Cutters — Catalog 81, 32 pp, contains specifications of company's line of tube cutters and expanders for fire tube and water tube boilers, condensers-coolers, heat transfer units, refinery still tubes, others. Also gives necessary information on operating accessories. Many excellent demonstrations of product application are included among the 300 illustrations provided, as well as tables of sizes, ordering tips and distributors. The Gustav Wiedeke Co.

219 Tubes and Plates — Publication B-2, 46 pp, covers the subject of tubes and plates for condensers and heat exchangers. Fields of application and particular problems encountered in each are described. Information on condenser tube alloys, plates for tube sheets and baffles, manufacturing methods, installation, operational factors affecting tube life, corrosion factors in condenser tube service is presented. A section of physical properties and data included. The American Brass Co.

220 Tube Cleaners — Bulletin G-515 describes company's line of air, steam and water driven tube cleaners and accessories. Photos of the various types of cleaners are included, along with descriptive details and specification data. Elliott Co. — Roto Plant, Div. of Carrier Corp.

221 Life Extension for Condenser Tubes — The 32-pp current edition of this booklet reports on research into the causes of corrosion and means of combating them, as well as the choice of condenser tube materials. Points out that Admiralty metal, long a standard for power plant condenser tubes, works satisfactorily in most installations, but other alloys may be necessary in others. Revere Copper and Brass, Inc.

222 Tube Expansion Control — Bulletin 64 describes a tube expansion control which automatically controls expansion by accurate measurement of torque. Advantages are detailed and specification data furnished. Airetool Mfg. Co.

COAL AND ASH HANDLING

223 Improved Crushers — Bulletin 12-C, 16-pp, describes company's line of crushers for reducing coal, coke, glass cullet, gypsum, lime, metal turning, sugar, sulphur and similar lump materials. Covers Knittel ring type crushers, two-stage double-roll crushers, single-roll crushers, and double-roll crushers. Photos, dimen-

sional drawings and full specifications are included. Stephens-Adamson Mfg. Co.

224 **Shredders, Crushers** — Bulletin 257 describes and illustrates hammermills and shredders, rolling ring and special crushers for reducing chemicals, minerals, ceramics, and other materials including wood waste. Discusses construction features of the line and includes dimensions. American Pulverizer Co.

225 **Why Liquid Diffusion** — What liquid diffusion can do for power plants is explained in Form B, which tells how liquid diffusion compounds work and gives four practical applications. These include dust control in coal handling, fly-ash control, coal storage pile treatment and boiler cleaning. Johnson-March Corp.

226 **Jet Ignition Stoker** — Information regarding comapny's jet ignition stoker is presented in Bulletin G-85. Rapid response to load change, ignition stability, efficient combustion, and a simple hydraulic drive are features described. Jet ignition stokers adapted to boilers in specific industries are shown and a typical fuel chart with comments and ASTM rank is also included. Babcock & Wilcox Co.

227 **Spreader Stoker** — Sixteen-pp Bulletin 800 describes manufacturer's Type C-C RotoStoker, a relatively small spreader stoker offering continuous cleaning and ash discharge advantages of larger units, without need of a basement for ash-removal. Explains this and other operational advantages of the stoker, which is adapted to modern steam boilers with output capacities of about 5000 to 75,000 lbs of steam per hour. Detroit Stoker Co.

228 **Water-Cooled Stoker** — Design and operating advantages of the Vibragrate Stoker are outlined in this illustrated bulletin. A large cutaway view details component parts of the stoker and explains operating features. Other drawings show installations. American Engineering Co.

MECHANICAL POWER TRANSMISSION

229 **V-S Drive Selection Tips** — Bulletin 20P50, 44 pp, carries handy multicolor tables for quick and easy selection of variable speed Texrope drives. In addition to providing these tables for A, B, C and D section variable speed drives, booklet includes information on design features, drive principles, horsepower rating tables, speed range table. Allis-Chalmers Mfg. Co.

Postage-free cards for ordering catalogs are on page 101. You may also use the cards to order literature mentioned in the ads.

230 **Flexible Cushion Coupling** — Bulletin A669, 12 pp, describes the Paraflex, a flexible cushion coupling, designed to automatically compensate for all combinations of misalignment and end float. Cutaway views and drawings are included, as well as coupling selection data and a table listing service factors for couplings. Dodge Mfg. Corp.

231 **Controlled Speed Systems** — Eight-pp Booklet F-1952 describes typical installations for controlled automatic variable speed systems, including control of liquid level, pressure, rewind tension, speed sensitivity, load, position

Don't Let High Fuel Costs Burn Up Profits

AIRETOOL

TUBE MAINTENANCE EQUIPMENT GETS RID OF POWER-ROBBING SCALE-CLOGGED AND LEAKY TUBES

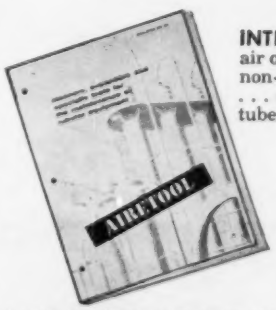
In minutes . . . not hours . . . AIRETOOL TUBE CLEANERS will clean out power-consuming profit-robbing scale-clogged tubes.

Faster than ever before, AIRETOOL CUTTERS remove faulty tubes . . . In less than half the time you would expect, AIRETOOL'S TUBE EXPANSION SYSTEM automatically rolls new tube ends to accurate, tight, leakproof joints. There's no doubt about it . . . you need AIRETOOL Equipment for your tube maintenance program!

CONDENSER CLEANERS — fast, powerful, easy to operate. Muffled motor, built-in flushing system cools drill, removes cuttings.

TUBE CLEANERS — rugged, durable, quickly removes hardest scale. Air driven motors in wide range of sizes and speeds. Heads available for all types of tubes.

AUTOMATIC TUBE EXPANSION CONTROL SYSTEM — rolls tube joints to uniform tightness, gives maximum bonding, eliminates distortion and over-rolling. Cuts rolling time from hours to minutes.



INTERNAL TUBE CUTTER — New . . . air or electric driven motor . . . cuts steel non-ferrous tube sheets 1" to 4" thick . . . quickly removes leaky or damaged tubes.

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SPRINGFIELD, OHIO

Write for Airetool Bulletin No. 60. Illustrated . . . shows complete line of Airetool tube maintenance and construction equipment plus Airetool specialty tools.

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Here in a new substation just north of Tulsa, as in many other locations, the Public Service Company of Oklahoma uses C & D PlastiCell batteries as an always-dependable source of power for switchgear control. By opening and closing circuit breakers, operating pilot lights and control relays, C & D PlastiCell batteries help keep vital switchgear equipment on the job.

Just as the Public Service Co. of Oklahoma has found C & D PlastiCell batteries to be specifically designed and engineered for control service, you'll find they'll meet your every need for all control, switchgear and auxiliary power needs. In C & D PlastiCell batteries you get:

Dependable standby power (160 A.H.) is provided by this C & D 60-cell PlastiCell battery.

- **Long life**
  due to exclusive suspended and supported plate construction; extra-thick, triple insulated plates.
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  because plastic jars are lighter, break-resistant and require less space.

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or link synchronization, temperature, multiple drive conveyors, wide range speed, others. Provides information on determining preliminary planning and obtaining maximum efficiency in controlled speed systems operation. U. S. Electrical Motors Inc.

PUMPS, COMPRESSORS

232 Controlled Volume Pumps — Bulletin 953, 24 pp, describes and illustrates use of controlled volume pumps in industrial water treating systems. Construction and operation features are described, capacity-pressure ranges and speed and stroke length adjustments are charted. Typical chemical feed and water testing systems are presented through text and diagrams; and an analysis of boiler water treating systems, cooling water treating problems, and systems for waste and sanitary water treatment included. Milton Roy Co.

233 For Abusive Pumping Jobs — Catalog 4906, 36 pp, covers centrifugal pumps for wide industrial use and especially adapted to handling ashes, abrasive mixtures, slurries, hot and corrosive liquids. It describes several basic types: a horizontal shaft, single-stage side suction pump; a horizontal shaft, single-stage, rear-entrance automatic priming pump; vertical shaft pumps with standard, overhead and quill bearings for wet pit applications. Nagle Pumps.

PACKINGS, SEALS

234 Mechanical Packings — Featured in 24-pp Catalog 56 are several recent packing developments including the multi-purpose Bel-Vee V-Ring packings, the long wearing criss-cross braid packing series, twisted foil packings for oil and distillate temperatures to 1000 F, and an Inconel-wire reinforced plastic packing for valves handling superheated steam at temperatures up to 800 C. Packings for every industrial application are covered and a recommendation chart is included. The Belmont Packing & Rubber Co.

235 Packing Catalog — Catalog 54 contains literature on company's line of packings and gaskets to serve a variety of industrial needs. Among the items featured are metallic packings, fibrous packings, plastic packings, gaskets and sheet packing, as well as high-temperature anti-seize compounds. A section of engineering data and conversion tables is included. Felt Products Mfg. Co.

WATER CONDITIONING

237 Water Treatment — Bulletin 5000, 24 pp, explains the reason for boiler water treatment and tells services offered by company in providing formulations for individual plant requirements. Covers pretreatment, internal treatment, treatment application, blow-down adjustment, test control. Dearborn Chemical Co.

238 For Boiler Protection — Scav-Ox, a 35 per cent hydrazine solution for removing dissolved oxygen from boiler feedwater, is described in this 16-pp illustrated booklet. It covers in detail the use of the solution for protecting low, medium and high pressure boilers, discussing determination of dosage, recommended methods of application, testing methods for hydrazine, and properties and handling of the material. Comprehensive operating data given. Olin Mathieson Chemical Corp.

239 Feedwater Heaters — Open-Coil, tray-type feedwater heaters and purifiers of both deaerating and nondeaerating type are presented in 12-pp Bulletin 117-A. Construction and operational features of the heaters are explained and illustrated, and more than a dozen available models are pictured along with application suggestions. They cover capacities from 3000 to 300,000 lb per hour. Stickle Steam Specialties Co.

240 Boiler Water Treatment — Chemical reduction of oxygen in boiler feedwater with hydrazine is the subject of 10-pp Bulletin BW-7. Economy and operation, handling of the Deoxy-Sol, methods of analysis and other details are covered. A bibliography lists supplementary reading. Fairmont Chemical Co., Inc.

241 pH and Chlorine Control — The 13th (1957) edition of company's handbook "Modern pH and Chlorine Control," 100-pp, incorporating theory and practice of colorimetric analysis, serves as a reference for quantitative determination of pH, chlorine, phosphate, nitrate, sulfate, hardness and other tests. Slide comparators and complete test kits are illustrated. In addition to standard pH determinations, methods are outlined for quantitative analyses of phosphate, calcium, magnesium, silica nitrate hardness. Available to qualified power engineers, please state your job title. W. A. Taylor Co.

242 Demineralization Data — Bulletin WC-111A, 32 pp, is company's revised booklet on demineralization (ion exchange). In addition to basic sections on application of demineralizers, principles of operation and chemistry of ion exchange resins, this bulletin includes detailed information and charts on design and materials of construction. Includes comparison charts on multi-bed, mixed-bed and scavenger or polishing demineralizers. Detailed layouts of each type of system and operating cycle drawings are provided. Other sections cover automatic control, regenerating systems. Graver Water Conditioning Co.

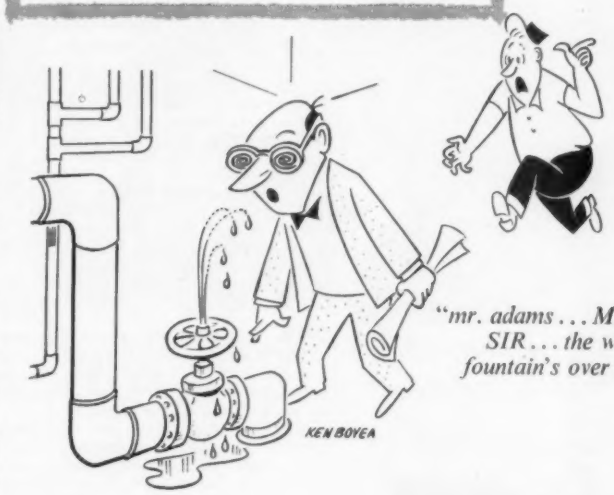
243 Handbook on Demineralizing — Comprehensive 40-pp Bulletin 5800 compares various methods of water treatment, indicating the comparison between demineralizers and evaporators. It discusses the characteristics of the various types of available cation and anion exchange materials and offers data on operating costs of demineralizing. It tells when to use two-bed, three-bed, four-bed, mixed or mono-bed demineralizers. It also indicates when decarbonators or vacuum deaerators should be installed. Cochrane Corp.

REFRACTORIES, INSULATIONS

244 Refractory Castable — Bulletin R-40 describes the use of Kaocrete, company's refractory castable, in boiler ashpits. A discussion of the various methods of ash removal, along with the maintenance problems peculiar to each, is presented. Four installations detailed. Refractories Div., The Babcock & Wilcox Co.

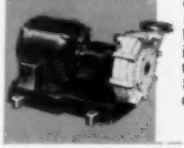
245 Refractory Mortar — This is a 24-pp manual covering the use of Lumnite calcium-aluminate cement as a mortar mix for gun-applied linings in power plant, refinery and metalworking equipment. Includes data on mortar preparation, placing procedures, curing; also general instructions, and information on use of Lumnite cement as a masonry mortar for laying brick. Sections are devoted to types of

Life in these excited states...



"mr. adams... Mr. Adams... SIR... the water fountain's over here!"

"WAM" PUMP
finest you can buy

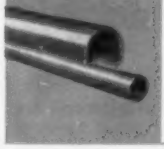


Highest pumping efficiency, with faultless corrosion resistance. Hard rubber casing and impeller; Hastelloy C shaft. 80 gpm. *Bul. CE-55.*

THRIFTY-THROATED VALVES

Liquids never touch metal in Ace diaphragm valves! Rubber or plastic-lined cast iron, or solid plastic bodies. Sizes ½ to 6". Ask for facts.

ACE-ITE
all-purpose toughie



High-impact, rubber-plastic, most economical for average chemicals. ½ to 6". Screw or solvent welded fittings. Valves ½ to 2". NSF-approved. *Bul. 80A.*

Why men of vision choose ACE equipment

Men with a weakness for profits somehow manage to keep equipment "on stream" full time with no corrosion shutdowns. You'll find they reach for Ace corrosion-engineered equipment time and again. Now nine kinds of Ace pipe ... plus pumps, valves, tanks, and special equipment to solve most any corrosion or contamination problem.

RIVICLOR
ageless strength

All-purpose rigid PVC. Sched. 40, 80 & 120, ½ to 4". Threaded or socket-weld fittings. Valves ½ to 2". NSF-approved. *Free Bul. CE-56.*

See our pages in CEC Catalog!

ACE processing equipment of rubber and plastics

AMERICAN HARD RUBBER COMPANY
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aggregates and data on weight, strength and thermal conductivity; a bibliography on refractory concrete is included. Universal Atlas Cement Co.

VALVES, TRAPS AND PIPING

246 Boiler Blow Off Valves — Bulletin E-125, 24 pp, describes and illustrates the design and construction of company's quick-operating valves, angle valves, Y valves and duplex units specifically designed for boiler blow-off service. Includes dimensions. Everlasting Valve Co.

247 Composite Valves — This 24-pp catalog, Form 186, features company's line of bronze, iron, steel and corrosion resistant valves. In addition to descriptions of component features, it contains photos, cutaway views and complete specifications. The Wm. Powell Co.

248 For High Pressures, Temperatures — Bulletin B-453, 12 pp, describes company's high temperature and high pressure valves for service in steam power plants and related installations. Cutaway views illustrating design and construction features are included, as well as temperature-pressure ratings table, selection chart, dimensions and weights, and other data. Yarnall-Waring Co.

249 Butterfly Valve Manual — Forty-pp Catalog B-2 is designed to help power engineers select valve types, understand their characteristics, and determine space requirements. It includes such useful data as: pressure drop and flow tables, conversion tables, theory and application, recommended materials, and describes rubber seat butterfly valves from 4 in. diam up, for handling liquids and gases. Photos, drawings and diagrams amplify the text. The Henry Pratt Co.

250 Check Valves — Twenty-pp Catalog 30A presents company's line of tilting-disc check valves made in iron, bronze and steel for working pressures to 2500 psi. Explains operating principles of tilting disc construction, discusses closing without slam, reduced loss of head, other advantages. Includes construction details, sizes. The Chapman Valve Mfg. Co.

251 Choosing the Right Valve — Presenting valve selection as a matter of matching the valve's service characteristics with service requirements of the job, this practical 20-pp booklet explains and illustrates basic design features of gate, globe and check valves. It tells, in non-technical language, how each of these valve types works, and where it is suited for use. Disc, stem connection, bonnet and bonnet-joint characteristics are discussed and illustrated. Crane Co.

252 Industrial Valves — Bulletin 507V illustrates and describes company's line of industrial valves for control of air, gas, liquids and solids. Features photos and descriptive detail on a variety of valves, including butterfly valves, wafer butterfly valves, treaded butterfly valves, slide valves, check valves, proportioning valves and others. W. S. Rockwell Co.

253 Industrial Valves — Condensed Catalog 105, 28 pp, contains data on valves for a wide variety of applications. Includes dimensions and illustrations describing non-return (stop-check) valves, globe and

LARSON-LANE STEAM AND CONDENSATE ANALYZERS

FOR ACCURATE MEASUREMENT OF STEAM CONDUCTIVITY

MOST modern and efficient system of removing volatile amines, ammonia and carbon dioxide prior to recording steam conductivity. This thoroughly effective steam degasser uses a cation exchange resin for the removal of ammonia, morpholine, cyclohexylamine, and reboiling for the removal of CO_2. Constant sample temperature is maintained. Taps provided for drawing sample for other analyses.

Larson-Lane Steam and Condensate Analyzers make possible rapid and accurate measurement of steam purity, completely essential for efficient boiler operation.

A smaller, less expensive unit, the CH-16 provides for removal of ammonia and amines from steam condensate without the necessity of reheating. Condenser leakage is readily detected with this model in the presence of volatile amines or ammonia.

Write today for complete technical details.

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89 Commerce Road, Cedar Grove, Essex County, N. J.

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SHUTS OFF—but TIGHT

LUBE-SEAL Swing Gate VALVE

Proved on gas and steam lines, as well as on lines carrying heavy or viscous liquids, this valve easily closes TIGHT—with absolutely NO LEAKAGE—and just as easily opens for full, unobstructed flow.

After the lever lowers the gate into the closed position, plastic lubricant is forced by means of a screw down through the channels so that the faces of the gate are sealed tight against the valve body. To open the valve, the screw is backed off to relieve lubricant pressure.

That's all. It's rugged, simple, easy to operate, practically fool-proof in even the toughest service. Available in pipe sizes to 2½"; larger sizes available soon.

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Sales Representatives in Principal Cities

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angle stop valves, pressure seal design, angle univalves and small size globe valves designed for chain or extension operation in vertical lines. Edward Valves, Inc.

254 To Get at Those Valves — This little folder describes a sprocket rim with chain guide. The rim adjusts to fit all valve wheels. Babbitt Steam Specialty Co.

255 Swivel Joints — Advantages of company's self-aligning swivel joints for steam, hydraulic and other applications are detailed in 12-pp Catalog 265-B. In addition to dimensional data, working pressure ratings, specifications and installation details, it includes photos, cutaway views, diagrams. Barco Mfg. Co.

256 Trap Service Guide — To promote better trapping practice, pocket-size 32-pp Bulletin 7511 offers practical tips on installation, testing, and maintenance. Chapters are devoted to inspection and repair, trouble shooting, parts identification. Capacity charts are provided, also tables showing interchangeability of company's trap parts. Other sections deal with strainers, check valves, automatic trap drains. Armstrong Machine Works.

257 Materials for Main Steam Piping — Entitled "The Plastic Ductility of Austenitic Piping Containing Welded Joints At 1200 F," this 16-pp bulletin deals with an investigation into the problem of selection of materials for main steam piping. Gives stress rupture characteristics of type 316 and 347 stainless steel piping adjacent to welded joints. Pittsburgh Piping and Equipment Co.

258 Flexible Hose, Bellows — Sixteen-pp Catalog 156 describes applications and use of flexible metal hose and bellows. Engineering specifications and sizes, pressure ratings, materials and fitting attachments are included. Detailed drawings and pictures facilitate specification of individual applications. Charts of the various metal-formed bellows and hose are provided. Flexonics Corp.

HEATING

259 Electric Heating Units — Catalog 50, 50 pp, contains complete engineering data on electrical heating units and equipment, including strip elements, finstrip elements tabular elements, cartridge elements, ring elements, immersion heaters, circulation heaters, radiant heaters, forced air duct heaters, unit heaters, hot plates and others. Includes photos, dimensional drawings, prices, standard rating tables. Edwin L. Wiegand Co.

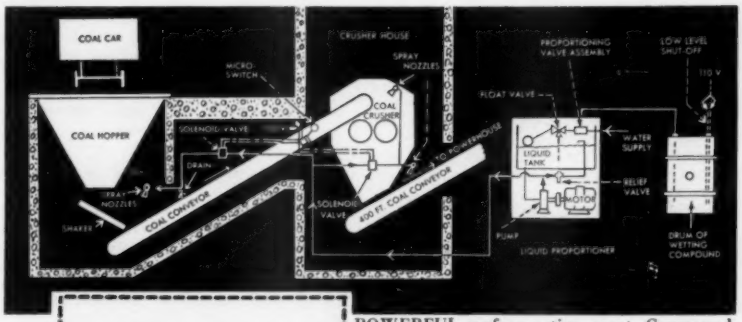
260 Overhead Heating Units — Bulletin P 1-57, 16-pp, contains photographic reproductions of overhead gas-fired heaters, as installed in a variety of commercial and industrial plants. How this type of heating solved specific heating problems is told. Prat-Daniel Corp.

261 Unit Heaters — Bulletin FAS-1, 24 pp, describes horizontal and vertical discharge unit heaters for replacing process exhausted air with warmed fresh air and for comfort ventilation. Dimensions, capacities, and suggested methods of installation are given, and photos, drawings and diagrams are included. L. J. Wing Mfg. Co.

OTHER EQUIPMENT

262 Centrifugal Dust Collector — Twelve-pp Bulletin 100 introduces the

JOHNSON MARCH ► chem-jet DUST CONTROL SYSTEM



POWERFUL surface active agent, Compound M-R, treats coal at four critical points in a power plant.

LOW COST:
Investment
Operation
Maintenance

...typical users of Chem-jet Dust Control Systems:

- Consolidated Edison Co.
- Philadelphia Electric Co.
- Niagara Mohawk Power Corp.
- Public Service Co. of Colo.
- Georgia Power Co.
- N. J. Power & Light Corp.
- Metropolitan Edison Co.

HOW LOW-COST CHEM-JET STOPS DUST AT ITS SOURCE

- **Effective Dust Control—**
  Chem-jet attacks a dust problem by allaying the dust before it is airborne.
- **Low Cost System—**
  Low first cost, low operating costs, low maintenance cost.
- **Engineered Package—**
  Chem-jet can be engineered for widely varying conditions. Installation is supervised, each system designed for specific problems.
- **Compact Design—**
  Eliminates bulky hoods, ducts and fans, and extra costs of collection and disposal.

Get complete facts on low cost Chem-jet, the only system of its kind. Write today to Johnson-March Corp., 1724 Chestnut St., Philadelphia 3, Pa. Ask for Bulletin CJ-1.

JOHNSON MARCH
DUST CONTROL ENGINEERS
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Cyclo-trell multiple tube dust collector which operates on centrifugal collection principles and incorporates new features to boost collection efficiency and gas handling capacity. An illustrated explanation of operation and construction of this collector is accompanied by collection efficiency and capacity nomographs. Tables give design data for six sizes, from three to 20 tubes. Research-Cottrell, Inc.

263 Corrosion Inhibitor — Bulletin 420-12-9 describes manufacturer's Composition TG, a sodium-zinc hexametaphosphate corrosion inhibitor for water systems, stressing its superiority in controlling corrosion in water mains and cooling equipment. Provides comparative graphs showing flow coefficients, rate of film formation as determined by weight loss and current flow, and schematic drawings of feeding methods. Calgon Co., Hagan Chemicals & Controls, Inc.

264 Product Guide — Manufacturing facilities for company's line of steam turbines, turbine generators, ship propulsion units, feed pumps, centrifugal compressors, blowers, centrifugal pumps, reduction gear, and other products are described in this profusely illustrated 50-pp catalog. Photos show manufacturing procedure. De Laval Steam Turbine Co.

265 Bucket Elevators — Comparison of elevator types and selection of bucket elevators for a variety of applications are covered in 80-pp Catalog be-55. Specifications and dimensions for centrifugal discharge, perfect discharge, continuous bucket, gravity discharge elevator-conveyors, pivoted bucket carrier, bulk cement systems, and marine legs are included, as well as supplementary information on the elevator-lowerator, vertical arm elevator, buckets, bucket punching, mounting of buckets, belt splicing, other factors. Webster Mfg., Inc.

266 Steam Turbines — The advantages of company's solid wheel turbines, axial flow turbines, single stage and multistage, are outlined in illustrated Bulletin S-140. Describes various models in their line and includes application photos. The Terry Steam Turbine Co.

267 Equipment Selector Charts — Bulletin CE-50, 20 pp, contains selector charts on corrosion-resistant equipment for process industries. Tables cover general considerations in selection of material, physical properties, corrosion resistance, techniques and skill in manufacture of equipment. Describes rubber and plastic pipe, tubing and fittings; valves; pumps; lined tanks. American Hard Rubber Co.

268 Corrosion, Abrasion Control — Modern practices and products for the positive protection of metal equipment from the effects of corrosion and abrasion are described in this 16-pp bulletin. Covers factory and field application of rubber or synthetic linings to metal parts or products, and maintenance coatings available for application by plant personnel. Goodall Rubber Co.

269 Steam Engines — Bulletin 307, 8 pp, contains detailed information on advantages and applications of company's horizontal types steam engines. Sectional drawings, engineering data and construction details are included in the bulltein. Troy Engine & Machine Co.

270 Precipitation Products — Twelve-pp Bulletin G406 contains helpful information on company's various precipitation products, including electrical precipitators, multiclone mechanical dust collectors, combination multiclone-precipitator units, Dualaire filter-type dust collectors and Holo-Flite processors. Also illustrates a number of typical installations. Western Precipitation Corp.

271 Preheating Combustion Air — This well-illustrated 36-pp booklet explains fuel savings and increased performance made possible by using waste heat in flue gases to preheat incoming combustion air. Also covers increased boiler output, ability to use lower grade fuels, other advantages afforded. Booklet contrasts regenerative with recuperative preheaters; explains operating principle and structural details of the Ljungstrom air preheater. Applications for other than power boilers are also covered. Air Preheater Corp.

272 Insulated Stack — This illustrated folder on company's pre-cast insulated stack contains complete product information, including advantages and description, specifications, suggested installation methods. Van-Packer Corp.

273 Ventilation Units — Bulletin FM-315, 25 pp, describes basic construction of company's package propeller fans for commercial and industrial applications. Illustrated case histories of typical installations are included, as well as performance data rating tables, performance charts. Buffalo Forge Co.

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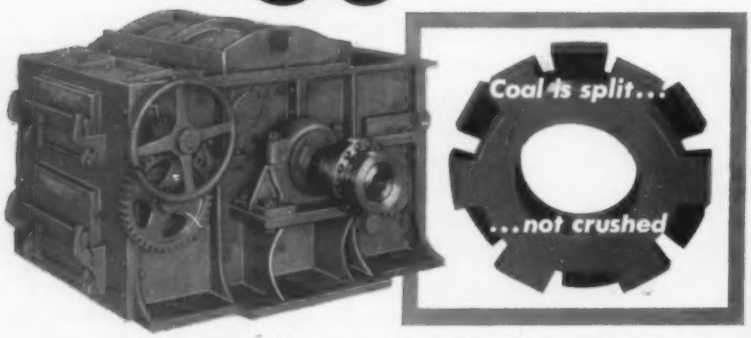

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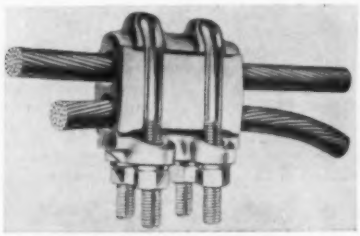
continued from page 99

36—PARALLEL CLAMP connects copper, aluminum, ACSR

Engineered for dependability in feeder, transmission, and primary distribution connections, this heavy duty all aluminum parallel groove clamp connects aluminum, copper, and ACSR. Only three connector sizes cover the range



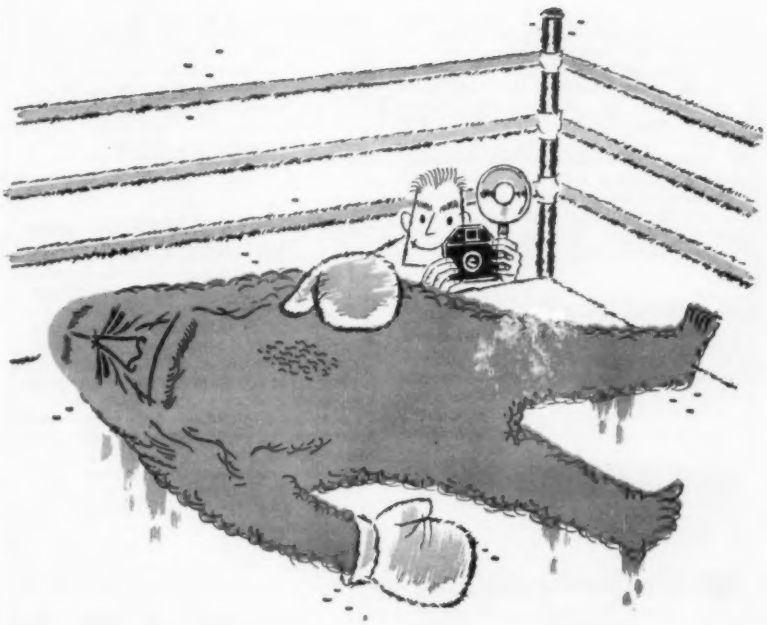
from 3/0 through 954 Mcm. Massive design and a large spacer protect against galvanic action, company says, and generous contact area and sustained contact pressure make low-resistance connections that can carry heavy overloads. Aluminum U bolts and tapered bell mouths are designed to minimize cold flow and eliminate cable chafing. Modified V-groove produces wiping action on cable to assure good electrical performance over full range. U bolts are captured so they can't get lost, heat treated to take intense clamping forces. Burndy Corp.

37—BALL VALVES for heavy duty ammonia compressors

The flat "plate" or "poppet" has been replaced in the BV Ball Valves with multiple steel balls — claimed to result in less resistance, better seating, greater life and improved compressor performance. The ball valve passes 26 per cent more gas, according to test data announced. The two principles on which valves were developed are: (1) gas flows freely around a ball, with minimum restriction and, (2) a ball revolves, seating on a different part of its surface with each stroke of the piston, providing longer wear and more perfect seating. Reported to offer a new concept in suction and discharge valves, these are also said to be quiet in operation and vibration-free. Ball Valve Co.

38—ILLUMINATION CONTROL monitors light levels

Model 1099 Luminaire Illumination Control is designed to monitor light levels and signal a relay to switch lights on or off automatically. The instrument is said to feature automatic operation of light switches without regard to time of day, temperature, or weather conditions, with no consumption of electrical power except during a switching cycle of 30 sec. The basic relay design has been in use 25 years, company states, and this new version adds compactness and plug-in design to photoelectric reliability and economy. Also the number of components has been reduced. Operating levels are unaffected by temperature, voltage



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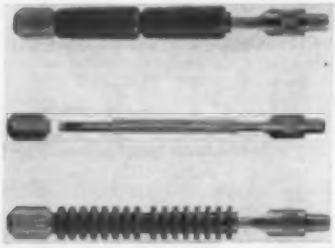
variations, or aging, it is stated, and there is no temperature build-up within the control due to self-heating.

Composed of a Photronic light-gathering cell which monitors the light level and generates its own current, and a Sensitrol relay which is signaled to start the control and operate the load switch, the Model 1099 contains no vacuum tubes, resistors or capacitors. Available in enclosed or uncovered types, the control can be equipped with an internal lightning resistor. Weston Instruments Div., Daystrom Inc.

39—TUBING SWABS with interchangeable rubbers

Both cup type and multi-disc type rubbers are featured in this line of tubing swabs. A pair of either kind fits onto the streamlined two-piece body. The rubbers are designed for flexibility of operation



and automatically adjust themselves to different loads. As manufacturer points out, this means that for a particular tubing size you need but one of these swab bodies and a pair of each of the two types of rubbers. To minimize friction wear and to speed the drop to the bottom, the swabs are designed to allow an annular clearance going down. When the swab is pulled, this clearance closes up and gives a seal that allows it to pull the heaviest load, company states. Byron Jackson Tools, Inc.

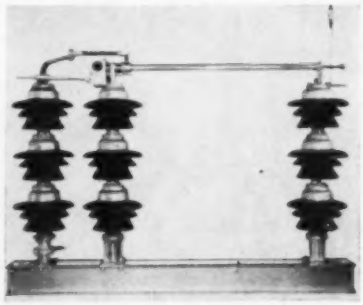
40—PRESSURE GAGES for general purpose applications

A-Line Pressure Gages include modern counterparts of company's general purpose line, the 500 Series, with design improvements in accuracy, movements, Bourdon tubes and optional extras. Costwise, this line is between company's higher accuracy Supergauge line and the less costly drawn steel case models. Fields of application are power and steam plants, refrigeration systems, and others where steam, water and non-corrosive oils and gases are principal measured media. A-Line Gages are reported to meet ASA Grade A standards with accuracies within 1 per cent of scale range for the middle (working) half of scale, where reading are generally taken (and 1½ per cent of scale for the remainder).

To simplify maintenance, socket, tube, tip, movement, dial, and pointer are removable as one unit (except in the 3½-in. dial size). This construction is designed to eliminate pointer shift due to stresses at gage connection, and makes it easy to remove the entire gage internals for inspection and recalibration. Movements, which must translate Bourdon tube motion into pointer position have been redesigned. Available movements include deep-brushed brass and all-stainless steel, as well as nylon-stainless steel. United States Gauge Div., American Machine and Metals, Inc.

41—AIR BREAK SWITCH has improved blade design

The design of Type RVL Air Break Switch incorporates a blade that swings into the open or closed position in one sweeping, continuous movement. The blade enters contact before pressure is applied and, in opening, all pressure is released before blade travel occurs. Blade



contacts have silver-tungsten inserts at hinge and clip end, and are designed to be self-cleaning. Ball bearings are permanently sealed and packed with silicone grease for free operation in extremes of temperature. The switch is available in ratings from 7.5 kv through 161 kv, with a 3 or 5 in. bolt cycle. Current rat-

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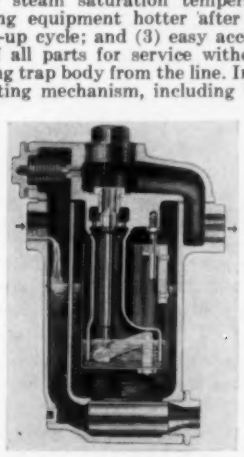
ings are 400/600 and 1200 amp. The switch can be mounted in a horizontal, vertical or underhung position. Bulletin 20-A gives further details on it. Royal Electric Mfg. Co., Inc.

42—DIAPHRAGM VALVE provides automatic flow control

When coupled with company's direct operated solenoid valve, which serves as pilot, this diaphragm valve provides automatic or remote flow control for higher pressure applications. Valve seat is separate from push rod, and is free to float to a tight seat; valve is guided from overhead by an over-size stem fitted within a bronze bushing. Designed for heavy duty service, valve is suitable for pressures up to 250 lb. Body is of cast iron, diaphragm of phosphor bronze, and valve, seat and push rod of stainless steel. Valve cap and diaphragm housing are bolted to valve body. Valve is available in 2, 2½ and 3 in. sizes — all screwed connections. It can be used with steam, air, water and other liquids, particularly heavy viscous ones. Johnson Corp.

43—TRAPS offer control, maintenance advantages

Utilizing basic design of this company's bucket traps, the 500-C series is offered for varying pressures: 0 to 150 psig. According to announcement, this line will cover 75 per cent of all trap applications. The traps — open float and thermostatic type — have three major advantages: (1) faster warm-up through more efficient venting and discharge of air and condensate in preliminary stage; (2) ability to discharge at 1 and 2 deg below steam saturation temperatures, keeping equipment hotter after initial warm-up cycle; and (3) easy accessibility of all parts for service without removing trap body from the line. Internal operating mechanism, including bucket



and linkage, is attached to the removable cover so that it is readily accessible.

A by-pass thermostat, built into the trap, is a liquid filled, Monel bellows type assembly pressure-and-temperature-compensated with action that follows the steam temperature curve from vacuum to 150 psig. This thermostat starts to open at 10 deg below saturation temperature and is fully open at 25 deg below. This thermostat by-pass, at the inlet side of the trap, is above the line inlet, so that a solid entrainment will not interfere with its operation while open during the warm-up stage. This trap series has horizontal straight-through connections, includes six models for ½ to 2 in. pipe. Wright-Austin Co.

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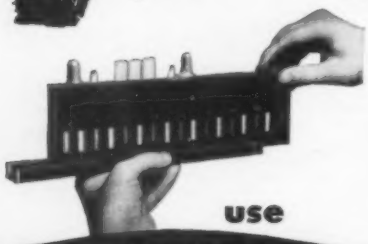

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Pulverized Coal

continued from page 64

dispersed, disintegrated and homogenized. The mill consists of a grooved conical rotor which rotates within a correspondingly grooved conical stator. The clearance between the rotor and stator is regulated by a calibrated adjustment device.

25—Fluid Energy Mill

In general, fluid energy mills (jet grinders) make use of jets of gas, air or steam under relatively high pressure to whip the material against and around the sides of the particular mill housings. Usually, these housings are some type of modification of a cone with the apex downward. Size reduction is brought about by impact of the particles with the casing or lining, by attrition, rubbing, etc. No mechanical moving parts enter into the size reduction process. For this reason, extraneous materials such as cutting bits, rock and shale have no immediate adverse action upon mill operation unless the quantity of such materials is quite excessive.

26—Pan Mills

Pan mills are made with two relatively large, solid wheel-like grinders or mullers rotating about horizontal axis on a flat or horizontal pan bed. The pan rotates in a horizontal plane. Material may be processed either wet or dry. Under such operations, the mills are said to be either wet pan or dry pan.

Dry pans are classed as those processing materials with up to about 5 per cent moisture. Wet pans will operate satisfactorily with materials having 15 to 20 per cent moisture, and in some cases up to 30 per cent.

These mills were once used in ore dressing processes but now are used mainly with clay processing, brick manufacture, and the like. They are of no particular consequence either in the preparation or utilization of coal. They have been used in a limited way in coal and charcoal briquetting and to some extent with clinker and cinder grinding.

27—Miscellaneous

Special mills for processing of wood pulp, paper and straw may be grouped under a product heading rather than under a mill-action type.

Classification

While the various mills from Hammer Mills through Coffee Mill are generally considered to be of the Secondary or Intermediate class, yet hammer mills, impact beater mills and the coffee mill type may all very well be placed under the heading of Fine Grinding and Pulverizing. The other mills described above, beginning with Ball Mill and running through Pan Mills, are all placed under the heading of Fine Grinding and Pulverizing. THE END

NEW ENGINEERING BOOKS

Symposium on pH Measurement. American Society for Testing Materials, Special Technical Publication No. 190, 1957. 104 pages, 6 by 9-in., paper. Published by ASTM, 1916 Race St, Philadelphia 3, Penna. Price $2.50.

During the 10 years which have elapsed since ASTM published the first symposium on pH measurement, significant developments in the field have occurred. To keep pace with these advances, a second symposium was organized and presented at the Society's 59th annual meeting, June 19, 1956. The present booklet records that symposium. Among the topics covered are:

Meaning and standardization of pH measurements, performance studies of reference-electrodes and their components at high-temperatures and pressures, modern developments on pH instrumentation, problems in measurement of pH of blood and other biological fluids, quantitative applications of pH measurements in analytical chemistry, theoretical and practical problems in the measurement of acidity in non-aqueous media, and indicator acidity functions for non-aqueous and mixed solvents.

* * *

Symposium on Steam Quality. American Society for Testing Materials, Special Technical Publication No. 192, 1957. 49 pages, 6 by 9-in., paper. Published by ASTM, 1916 Race St, Philadelphia 3, Penna. Price $1.75.

This work reviews present practices and introduces new techniques for obtaining information on steam purity for use in modern steam generators. Consideration is given to the problem of the need for more sensitive and accurate measurement. Extensive mathematical material is included, of interest to power engineers, water chemists, scientists and technicians in related fields.

* * *

Thermodynamics, by Virgil Moring Faires. Third Edition, 1957. 564 pages, 6 by 9⅜-in., cloth. Published by The Macmillan Co, 60 Fifth Ave, New York 11, N. Y. Price $7.50.

Published originally as Applied Thermodynamics, this work by Virgil Faires, professor of mechanical engineering at North Carolina State College, has been extensively rewritten and reoriented to reflect the growth in entropy which has taken place since the book first appeared in 1936. Faires presents a theoretical treatment of thermodynamics, with enough applications to motivate the student's comprehension in depth and breadth. His aim is to prepare the student for advanced study and at the same time to provide him with a satisfactory terminal course which emphasizes that knowledge which is most useful to engineers.

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Utilities Conservation

continued from page 68

application of the technical findings of the electrical and mechanical engineers to a continuing conservation program at the station. Attention is given to the corrective measures available to the activity, such as control and timing of building heat, steam quality improvement, flue gas temperature and CO_2 control, reduction in plant staffing, and condensate temperature and quality.

Survey Procedure

Because it was not practicable to build up a new staff for survey teams, it was essential to make full effective use of team members' time while onboard the station. Two procedures were developed to insure this; one was the accumulation of basic utilities operating and utilization data by the station before beginning the survey; the second was to schedule one engineer at a time on the station. The former is on order of the following:

Manufacturers' data and performance curves for boilers, turbine generators, condensers, pumps, air compressors, and so on; equipment histories for plant equipment; a listing of all steam, condensate, electrical and water meters; one-line diagrams of distribution systems; latest utilities cost studies; fuel consumption figures; heating plant, power plant operating logs and meter charts; dimensional data on steam systems; cubic feet of heated building space by category of construction; population; process loads. Also, meters should be calibrated and some portable instrumentation is required.

The team members visit the activity in the following order:

First week: electrical engineer.

Second week: mechanical engineer for steam distribution and utilization.

Third week: mechanical engineer for plant operations.

Fourth week: utility manager or team captain.

Potable water and telephone surveys are scheduled as is convenient.

Each team member utilizes the guide in conducting the actual survey; check sheets following the guide outline are employed and these actually become a part of the report. See Fig. 6. The utility team manager integrates the findings of the team members and drafts the final report. He insures that sufficient attention has been given to over-heating of buildings, proper utilization of steam, proper operation of heating plants, and night-time janitorial lighting, since these areas generally yield the largest savings with no capital outlay required. THE END

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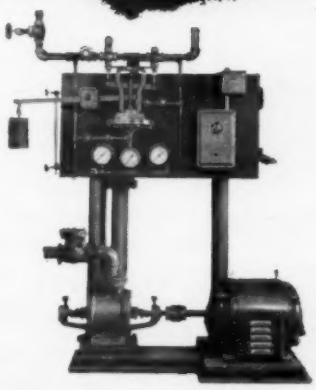

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1. Cuts fuel costs 10% to 25% by completely salvaging condensate and returning to boiler at 300 degrees or higher.
2. Raises production with higher, more uniform boiler pressure, higher temperature steam.
3. Reduces use of raw make-up water 85% to 90%.
4. Cuts maintenance on boilers, steam lines, traps and valves.
5. Improves quality by permitting operation of processing units at peak efficiency.
6. Cuts power used for pumping up to 75%, since system requires only 25 lbs.
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BIGELOW COMPANY, THE ..... *
Agency—Emil Mark & Company
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Agency—Tri State Advertising Co., Inc.
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Agency—Dozier Eastman & Co.
WICKES BOILER CO. ..... *
Agency—Price, Tanner & Willox, Inc.
WIEDEKE CO., THE GUSTAV ..... *
Agency—Hutzler & Associates, Inc.
WILLIAMS GAUGE CO. ..... *
Agency—Downing Industrial Advertising, Inc.
WILSON, INC., THOMAS C. ..... *
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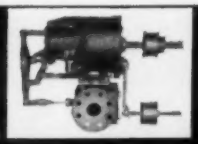
YARNALL-WARING COMPANY 8-9, 52
Agency—The Michener Co.

*Firms whose advertising is not in this issue but is appearing in other issues are marked with an **

STOP WASTING STEAM



Type EN Governor Fully enclosed, Self-lubricated

Let Troy Steam Engines and Generators produce dollar-saving "BY-PRODUCT POWER" from steam available for processing or heating. You can use this low-cost power for many operations in your plant, even against high back pressures!

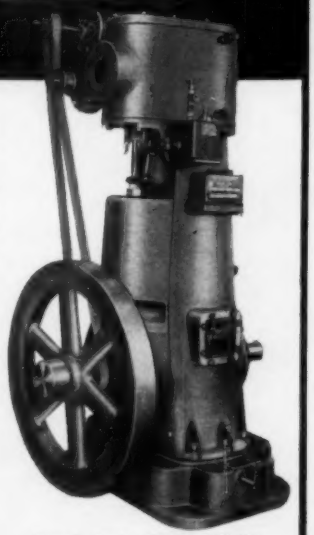
Use it for—

Generating Electrical Power

Mechanically Driving stokers, pumps, fans, compressors and other equipment.

It will pay you to investigate this source of cheaper power. TROY Equipment can be your key to COST REDUCTION!

Send for Booklet #308.



Type E. Engine, 12.5 to 100 HP.

TROY Engine & Machine Co.

704 Parsons Street Troy, Pennsylvania Tel. Troy 32

For more data circle 563 on Post Card

KO9

...the amazing electric motor cleaner!

KO9—your Short Cut to clean electrical equipment—does an outstanding job of cleaning and degreasing motors, generators, controllers, switches, panels, instruments, meters, refrigeration lines, etc.

Cleaning motors is a cinch—all you do is immerse the running motor in KO9, remove it minutes later as clean as new!

KO13 ... YOUR SHORT CUT TO FAST, SAFE CLEANING

KO13 is a truly sensational general purpose safety solvent that will clean just about everything ... leaves surfaces smooth and sparkling clean!

KO13 quickly removes grease, oil, dirt and grime from metal, wood and paint.

Ask for Literature Today

KOR CORPORATION

87—box 485

GARY, INDIANA

For more data circle 564 on Post Card

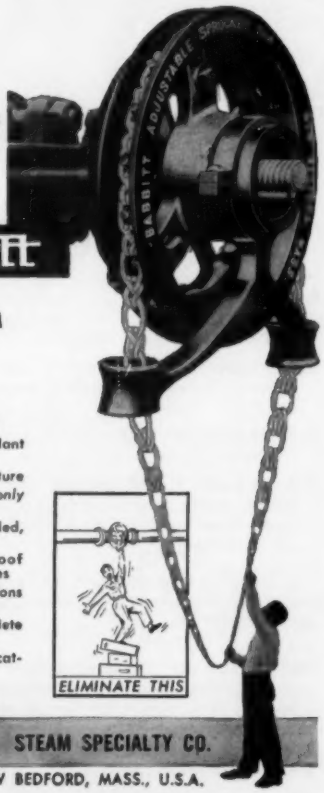
Safe Operation of Overhead Valves with a

Babbitt

Adjustable

SPROCKET RIM

with Chain Guide



- Simplifies pipe layout
- Fits any size valve wheel
- Easy to install and operate
- Operates any valve from plant floor
- Time and money saving fixture
- No maintenance, first cost only cost
- Packed, completely assembled, one to a carton
- Hot galvanized, rust-proof chain available for all sizes
- Easy to follow instructions with each unit
- Your supplier carries complete stocks
- Write for new descriptive catalog sheet and prices

Babbitt STEAM SPECIALTY CO.

4 BABBITT SQUARE, NEW BEDFORD, MASS., U.S.A.

For more data circle 565 on Post Card

this NO-COST TEST OFFER has CONVINCED thousands

... send for YOUR FREE "TEST CAN" of C-5 "hi-temp" ANTI-SEIZE THREAD COMPOUND!

For use wherever threaded connections are subjected up to 1800 °F. temperatures such as boiler, manhole, face plate studs, cylinder heads, and manifold studs or flange bolts on high temp steam lines and pumps.

Try C-5 and see why manufacturers, refiners and power producers have made it a part of their regular preventative maintenance program.

fel-pro C5 "HIGH-TEMP"

1614BR

- ✓ Ends Seizing and Galling even up to 1800°F.
- ✓ Reduces Wrench Torque
- ✓ Ends Stud Breakage
- ✓ Permits Repeated Re-use
- ✓ Speeds Assembly and Disassembly
- ✓ Protects Stainless Steel at all Temperatures

ANTI-SEIZE THREAD COMPOUND

C-5's exclusive colloidal copper formula separates mating metal threads and surfaces with cushioning, protective copper plating. C-5 prevents galvanic action and eliminates pitting even when dissimilar metals join. On mating metal surfaces, C-5 saves gaskets and countless man hours.

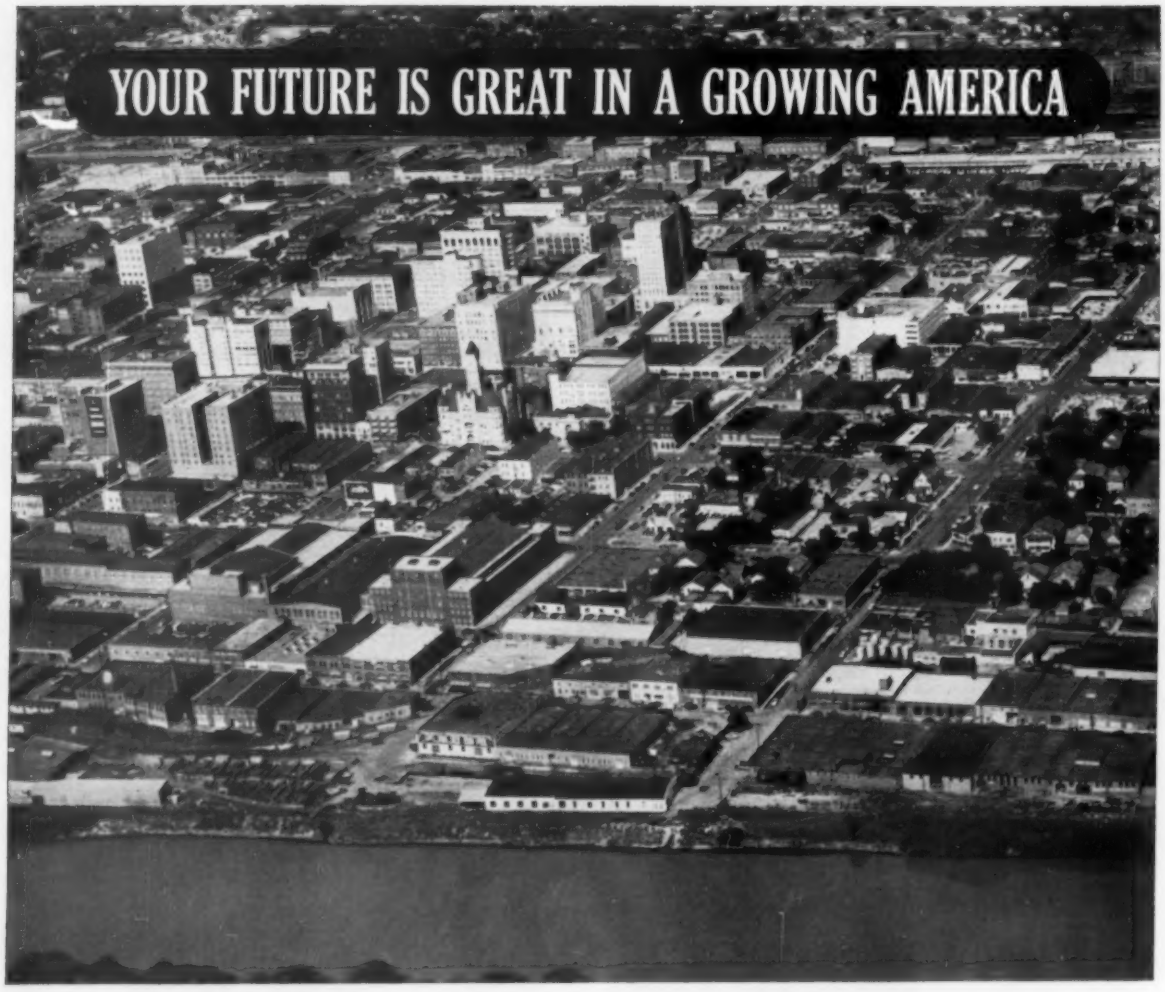
WRITE TODAY... For Your FREE Test Sample Can of C-5.

FELT PRODUCTS MFG. CO.

Dept. 76, P. O. Box 8609

CHICAGO 80, ILL.

For more data circle 566 on Post Card



THE CITY THAT DIDN'T EXIST A MONTH AGO

Every 30 days the U. S. adds as many new Americans as live in Norfolk, Va.—creating brand-new wants and needs which must be satisfied.

What does this mean to you? It means greater opportunities than ever before—in all fields. Home construction is expected to double by 1975. Power companies plan to increase output 250% in the next 20 years to provide the power for scores of new labor-saving devices. Clothing suppliers predict a one-third increase in 7 years.

With 11,000 new citizen-consumers born every day, there's a new wave of opportunity coming.

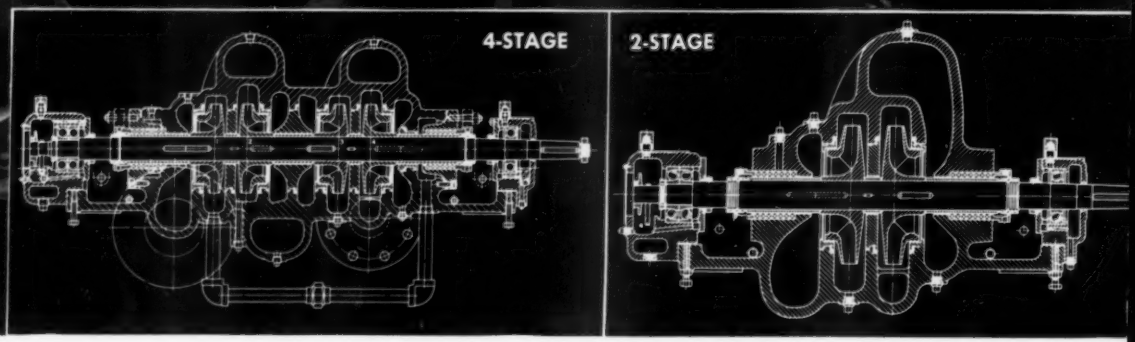
7 BIG REASONS FOR CONFIDENCE IN AMERICA'S FUTURE

1. **More people** . . . Four million babies yearly. U. S. population has *doubled* in last 50 years! And our prosperity curve has always followed our population curve.
2. **More jobs** . . . Though employment in some areas has fallen off, there are *15 million* more jobs than in 1939—and there will be *22 million more* in 1975 than today.
3. **More income** . . . Family income after taxes is at an all-time high of $5300—is expected to pass $7000 by 1975.
4. **More production** . . . U. S. production *doubles* every 20 years. We will require millions more people to make, sell and distribute our products.
5. **More savings** . . . Individual savings are at highest level ever—*$340 billion*—a record amount available for spending.
6. **More research** . . . *$10 billion* spent each year will pay off in more jobs, better living, whole new industries.
7. **More needs** . . . In the next few years we will need *$500 billion* worth of schools, highways, homes, durable equipment. Meeting these needs will create new opportunities for everyone.

Add them up and you have the makings of another big upswing. Wise planners, builders and buyers will act *now* to get ready for it.

FREE! Send for this new 24-page illustrated booklet, "Your Great Future in a Growing America." Every American should know these facts. Drop a card today to: ADVERTISING COUNCIL, Box 10, Midtown Station, New York 18, N. Y.

(This space contributed as a public service by this magazine.)



On 2- and 4-stage centrifugal pumps

WORTHINGTON SAVES YOU 10 to 30%

▶ **Elastic Seal Rings**—inserted into casing rings, end leakage problems, maintain peak initial and sustained efficiency—an exclusive Worthington feature. Designed to resist constant casing ring wear. These seals are standard on all UNB, UNQ pumps.

▶ **Advanced Design**—typical of the many advanced design features on these pumps is the liberally proportioned shaft which minimizes deflection and eliminates vibration. There is always a safe margin between deflection and clearances.

▶ **Complete Pump Experience**—a combination of Worthington 'know-how' and 118 years of extensive design, testing, and manufacturing skills on the world's broadest line of pumps for every conceivable purpose and application.

turn page to calculate your pump needs▶

Worthington's standard 2-stage UNB and 4-stage UNQ centrifugal pumps are basic for boiler feed pump and general service applications. They are built to exacting standards of dependability and long life. Each combines the engineering ideal of positive interstage leakage control, balanced design, and designed-in reliability. Delivery is competitive. And these pumps cost 10 to 30% *less* than previous models!

FIRST CLASS
PERMIT No. 11
Harrison, N. J.

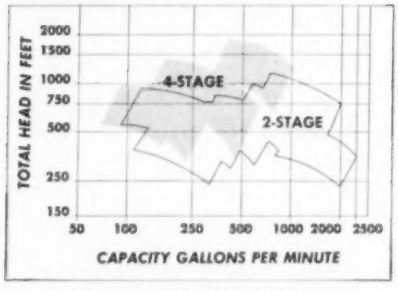
BUSINESS REPLY CARD
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

—POSTAGE WILL BE PAID BY—

WORTHINGTON CORPORATION
Engineered Products Section—A & SP
Harrison, New Jersey

New Worthington 2- and 4-stage centrifugal pumps let you

SAVE UP TO 30% PER PUMP!



2-STAGE & 4-STAGE COVERAGE CHART

Now Worthington—a respected name in pump manufacturing for 118 years—offers you savings of 10 to 30% on both 2-stage and 4-stage centrifugal pumps. These are the same totally-engineered, constantly checked and skillfully manufactured pumps used in every conceivable application throughout industry. They feature the same careful attention to detail: balanced design, elastic seal rings, oversize ball bearings, sturdy construction, easy accessibility. They represent the same extensive experience in design, construction and service found in every Worthington pump.

You can put this Worthington experience to work on your pump application problems right now. Simply send in the card below for a fast quote on any specific standard fitted pump requirement. All the information needed for selection and application is included. There is no obligation on your part, of course. With each quotation we send free elastic seal ring. Tear out and mail card now!

21-3

Driver Data (motor or turbine)_____

Pumping Application_____

Design Data

Capacity (gpm)_____

Total Head (feet)_____

Suction Head (psig)_____

or

Suction Lift (feet)_____

Pumping Temperature (°F)_____

Liquid to be Pumped_____

Name_____

Position_____

Name of Firm_____

Address_____

City_____ Zone_____ State_____

FOR FAST QUOTATION MAIL CARD TODAY!

Typical of Worthington's advanced engineering techniques is the elastic seal ring. Able to withstand severe hydraulic shock, designed to resist constant casing ring wear, yet resilient enough to permit a few thousandth of an inch slippage where needed. These seal rings are standard on all Worthington UNB and UNQ pumps. Examine one for yourself free by filling in card for quotation and mailing now. No postage required.

WORTHINGTON